American Meteorological Journal.

A Monthly Review of Meteorology
—AND—
Allied Branches of Study.

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THE AMERICAN

Meteorological Journal.

VOL. I. DETROIT, APRIL, 1885. NO. 12.

EDITORIAL NOTES.

IT gives us pleasure to announce that this JOURNAL is now the property of the W. H. BURR PUBLISHING COMPANY, a stock company organized under the laws of Michigan to do a general publishing business. By this change the future of the JOURNAL is much better assured than it could be by the private enterprise under which it was started. We bespeak for the company the favor of our readers. W. H. Burr is the manager of the company and the editing of the JOURNAL remains in the same hands as before.

From the next number—which begins volume II—the subscription price is reduced to two dollars per annum. With the second volume we expect to begin a series of articles on weather prediction and the use of weather maps. These articles will extend through several numbers and are intended for the general public.

We hope to continue the literary notes as heretofore and to add to the number of reporters. Our readers will find that these notes will enable them to keep track of the course of meteorological study over the world generally, with the advantages that they will have to read only abstracts, and that these abstracts will be often accompanied by suggestion or criticism by competent authorities. We hope that this part of the JOURNAL will grow in favor with our readers as they become more familiar with it.

In this number we enlarge the plan of the part of the JOURNAL which is headed "Correspondence." We will include in this hereafter, as heretofore, announcements of observations and discoveries with their discussion, and will also open its columns for such queries and suggestions as we have, up to this time, been accustomed to answer by letter. Although the queries are asked by individuals they often have a general interest. We will undertake to refer them to the best authorities when they can not be answered in this office, or we may leave them standing for answers from volunteer correspondents. From the questions which we admit in this number, our readers will be able to judge of the character and usefulness of this department of the JOURNAL.

With this number we complete the descriptions of Dr. Draper's meteorological instruments. These instruments are in use at the Central Park Observatory, New York City, and possess many unique and interesting features. The original descriptions are now entirely out of print, and we owe to Dr. Draper's kindness the privilege of reproducing them.

A NEW method of attacking the question of atmospheric electricity has been developed, in the experiments made by Lemström at Sodankylä, in the last two years. He has attempted practically to measure directly the electro-motive force of the electric currents of the atmosphere, if such exist, and their variations. Incidentally he finds reason to believe in a connection between auroral occurrences and meteorological conditions. He has succeeded in producing artificially the aurora, and what is of much more value, has given us a new and tangible method of studying the electrical condition of the atmosphere. The full reports of the work done by the expedition are not yet made public, but thus far enough has been learned to more than compensate the expenses incurred by the Finnish Government in fitting out and maintaining for two years these expeditions. Lemström's work will undoubtedly give a great impetus to the study of atmospheric electricity, and, we doubt not, may completely revolutionize our present methods of work. It seems to us in many respects comparable with Franklin's kite experiment.

CURRENT NOTES.

RAINFALL AT NASHVILLE.—According to Sergeant Jesunofsky's report of March 27, the average annual rainfall at Nashville, Tenn., for the past 14 years is 51.50 inches, and for the months—Jan., 5.16 inches Feb., 5.18, March, 5.45, April, 5.65, May, 3.36, June, 4.20, July, 4.91, Aug., 3.41, Sept., 3.32, Oct., 3.00, Nov., 3.88, and Dec., 3.96.

EARTHQUAKE LITERATURE.—The number of *Science* for March 6, 1885, (No. 109, vol. V.), may be called an earthquake number, as a considerable part of it is devoted to these phenomena. Among the contributors are C. G. Rockwood, Jr., W. M. Davis, and H. M. Paul; there is also a translation from Fouqué on the causes of earthquakes. The number is fairly indispensable to students of this natural phenomenon.

A FRIEND.—The New England Meteorological Society has a friend whose name we are not at liberty to mention. It is the daughter of a meteorologist who began his observation with the beginning of the century and continued it without interruption for more than a quarter of a century. This lady continues her father's work by forwarding the pursuit of the science wherever possible, and we learn that the vigorous New England Society has obtained assistance from her. We hope that there may be many such friends for the Society.

THE SOUND OF THE AURORA.—The question of the *noise of the aurora* does not seem to be settled yet. The following observation is old, but has just appeared in print. It is from the notes of the observer at Fort Confidence, Great Bear Lake, Brit. America, and bears date of March 5, 1839. We translate it from the *Preus. Statistik*, No. LXXVIII. "About a quarter of 5 A. M., a brilliant aurora was observed. It formed a semicircle which extended from the W.N.W. to the zenith. From there it was double and it ended near the earth in an elliptical figure of red, green, and purple color. This half-ellipse rose and fell and this motion was accompanied by an audible sound, which was like the rustling of silk. The sound lasted fully 10 minutes, and at its cessation the entire phenomenon suddenly ascended and disappeared.

REVIEW OF EUROPEAN WEATHER FOR JANUARY, 1885.—*Barom. Pressure.* From the 1st to the 4th there is a high pressure in the east over Russia and a minimum in the west; the maximum travels southerly and on the 5th hovers over southeast Austria, while the low pressure on the 7th is central near Bodö on the north Norwegian coast; another high pressure spreads over France, and on the 8th over the whole of central Europe. Northwest of Scotland a new disturbance appears. Over Germany the temperature has gone down as low as 10°; on the 11th the minimum in the northwest travels suddenly to Denmark, where the barometer falls below 28.54. Under the influence of the strong southwest winds the frost in Germany has disappeared. On the 12th the low pressure is central near Copenhagen, while in the west and north high pressure approaches. The minimum travels southerly to France and Italy; at the same time the high pressure in the north reaches above 30.43, with severe frost down to —26. On the 18th the barometer reaches 30.71, but on the 19th the high pressure travels to the southeast, and is on the 20th central near Lemberg (Austria). In Germany the temperature has again fallen to 0°; in the meantime the pressure in the west has considerably decreased. Till the 26th no change occurs, but on this date a low pressure appears in the north, and, uniting with the minimum in the west, the combined system spreads as an area of low pressure over the whole of western and northern Europe. On the 29th the low pressure has spread as far as Italy and the frost in north and west Germany has disappeared; only in south Germany freezing weather continues till the 31st. On this date the barometer over Ireland has fallen to 28.42 with stormy winds from the southwest and considerable precipitation.

Temperature—Germany. From the 1st till the 2d, on the 7th, from the 11th till the 14th, and from the 28th till the 31st it is above; from the 3d till the 6th, from the 8th till the 10th, and from the 15th till the 27th it is below the mean. Highest temperature at Kaiserslautern on the 30th 52°, lowest on the 20th, 23d and 27th, at Munich, 0°.

Ireland, Valentia. The temperature was below the mean on the 3d, 8th, 9th, 12th till 18th, 30th, and 31st; it was above the mean on the 1st, 2d, 4th till 7th, 10th, 11th, and 19th till 29th. Highest temperature, 52°, on the 4th and 10th; lowest, 34°, on the 15th.

Russia, St. Petersburg. The temperature was below the mean on the 1st, 2d, 8th, 9th, 18th, 25th, 29th till 31st; it was above the

mean from the 3d till 7th, 10 till 17th, 19th till 24th, 26th till 28th. Highest temperature on the 12th, 32°; lowest, 24°, on the 9th.

Sweden, Stockholm. Temperature below the mean: 4th, 5th, 8th, 17th till 27th; above the mean: 1st, 3d, 6th, 7th, 9th till 16th, 28th till 31st. Highest temp., 37°, on the 31st; lowest, 9°, on the 23d and 24th.

M. BUYSMANN,
Flushing, Holland.

LIGHTNING IS LESS DANGEROUS as the elevation of the clouds is greater. It is very common in India, at the commencment of the monsoon, but in a twelve years' residence, Meyrick knew of only two persons and three buildings being struck, though the population of lower Bengal is 600 to the square mile. In the Himalayas, 6,000 feet or more above the sea, buildings and trees are often struck. That winter thunderstorms are more dangerous than summer ones is probably due to the same cause.—*Nature.*

MICHIGAN WEATHER SERVICE:—A bill to increase its usefulness was introduced by Mr. Woodruff of the House of Representatives, and was recommended by the committees on Agriculture and Public Health. We have not been informed as to the farther progress of the bill; but we wish it success. The bill is as follows:—

SECTION 1. *The People of the State of Michigan enact,* That it shall be the duty of the Secretary of State to promptly disseminate throughout the State, as far as is practicable, information concerning the approach of storms, cold waves, or other meteorological information of importance to agriculturists, or to any other large class of citizens of Michigan, received from the United States signal service, or from the State board of health.

SEC. 2. Meteorological observers furnishing reports shall receive from the State for each report satisfactory to the secretary of the State board of health and to the secretary of State the sum of three dollars, which shall be full compensation for all duties performed by them. The reports provided for in this section shall be made under such rules and regulations as shall be adopted by the secretary of State and the State board of health.

SEC. 3. The Secretary of State, after having used the reports as provided for in section one of this act, shall return all meteorological reports received by him to the secretary of the State Board of Health, for permanent use in his office.

ROYAL METEOROLOGICAL SOCIETY.—The usual monthly meeting of this Society was held on Wednesday evening, the 18th inst., at the Institution of Civil Engineers, Mr. R. H. Scott, F. R. S., president, in the chair. Messrs. H. B. Baker, M. D., S. Dixon, R. Foster, and B. O. Meek, F. L. S., were elected Fellows of the Society. The following papers were read:—

1. "How to detect the anomalies in the annual range of temperature," by Dr. Buys Ballot, hon. mem. R. Met. Soc. The author shows that it is most likely that only a long continued series of observations can give some evidence of an interruption of rise and fall, especially in latitudes where the temperature of the same day in different years may differ by 20° C., as in St. Petersburg.

2. "Cloud Observing," by D. W. Barker, F. R. Met. Soc. As there is a great deal of confusion amongst cloud observers, not only as to the particular names of clouds, but more especially with regard to their movements, the author recommends that there should be two simple divisions, viz., "stratiform" and "cumuliform." To the stratiform belong all the higher forms of cloud and a few of the lower; to the latter belong the typical cumulus cloud always seen in the lower atmosphere. From the result of numerous observations, the author's conclusion is that the actual normal action of the cirro-filum cloud is along the line of filature, and that, knowing the bearing of the V or radiating point, the direction of its motion can be at once inferred. In all cases the V point first formed in the point from which the cloud is coming, but it will frequently be noticed that threads first appear parallel to a certain point on the horizon, and in all sorts of positions between this and the central V point.

3. "A suggestion for the improvement of radiation thermometers," by W. F. Stanley, F. R. Met. Soc. The author suggests that the radiation thermometer should indicate the amount of heat radiated by the sun upon a metal ball of a certain size, this being an object easy of uniform reproduction by mechanical means. For experiment, he made three hollow copper balls, which were cast with ordinary filed cores, and were of different weights. These balls were turned to exact external diameter of 1.4 in., with similar necks of the insertion of thermometers. The surfaces were oxidized by heating to resemble the oxidation produced by the atmosphere. In each of these balls a similar thermometer was inserted, closing round the neck just sufficient to keep it steady by cotton thread soaked in paraffin. The three thermometers thus enclosed in the metal balls, when exposed to sunshine and placed

at two inches above a piece of black board, appeared to register under similar conditions exactly alike. The experiments for three summer months gave from 6° to 11° difference between the sun and shade.

A LIGHTNING STROKE.—In his lecture on the 1st of February, in London, Prof. Tyndall reminded his audience that in the preceding lecture he mentioned incidentally the action of atmospheric electricity, and he now, by the kindness of Sir James Paget, was enabled to show some garments which had been worn by a man who, during a thunderstorm, took refuge under a tree. This was a very dangerous proceeding. The tree was struck by lightning, as was also the man, on whose clothing it had an extraordinary effect. His clothes must, however, have been very wet when he was struck; for had they been dry he would certainly have been killed. It was the clothing and not the man's body which had conducted the electricity. Displaying a boot, the sole of which was a mass of hobnails, and which had evidently belonged to a "son of the soil," he said that they must remember that the destructive effects of electricity were produced entirely where this wonderful power encountered resistance. So with this boot, they saw a part of it where the leather had been all torn; but in the sole the conductivity was good, and where the foot was on the ground the electricity passed harmlessly to the earth.—*Electric Review.*

OCEAN CURRENTS IN THE NORTH ATLANTIC.—Although somewhat lacking in precision, the following note from the New York *Sun* is not without interest:

The White Star steamer, Republic, left New York for Liverpool on April 24, 1884. Walter Kobbe, one of her passengers, when she was five days out, put into an empty appollinaris bottle a scrap of paper containing these lines:

On Board Steamer Republic, White Star Line, April 29, 1884.—Whoever returns this to 44 West Forty-eighth street will receive $5. WALTER KOBBE.

Mr. Kobbe corked the bottle and threw it into the ocean.

Mr. Kobbe returned from Europe in the summer. On Nov. 4 his mail included a letter bearing a Portuguese stamp and post-mark. The letter was as follows:

Island of Fayal, Azores, off Coast of Spain, Oct. 10, 1884.—Walter Kobbe, Esq., New York City.—*Sir:* The enclosed paper having been picked up at sea in a bottle about a mile off the southern coast of this island, I hasten to send it to you as therein directed, hoping that your promise will be duly fulfilled. I am, sir, yours truly, J. B. DE MELEIROS.

LEMSTRÖM'S AURORAL EXPERIMENTS.—In a recent number of *Nature* Professor Selim Lemström, of Helsingfors University, gives the results of the scientific expedition to Sodankylä, in Finnish Lapland, during the year 1883–4.

It will be remembered that during 1882–3, at the same place, Lemström made his quite successful "artificial aurora" experiment. The hillside of Orantunturi (1000 feet in height) was covered with a network of wire, having at intervals pointed conductors, making altogether, a large "discharging apparatus." When the current from a powerful galvanic battery was sent through this, a diffuse yellowish light, which in the spectroscope gave the characteristic auroral line, was seen at night, over the cone of the hill. Other hills in the vicinity did not have this luminosity. Later in the same year he was able to produce a veritable auroral beam. Tromholt repeated these experiments, but without success. The Government of Finland having provided further funds, the work of the former year was continued and carried out more in detail. After arrival, a "discharging train" was constructed on a low mountain, Komattivaara (437 feet high), the wire and points covering a surface of 364 square metres. A galvanometer placed in the circuit showed a current from the earth into the atmosphere. Observations of the same nature, the former year, showed that the direction of the current was reversed during auroral displays, *i. e.*, from the atmosphere to the earth.

Three other sets of apparatus were now set up, and the result of observations thus made seems to show that "close to the earth there is a stratum of positively electrified air, the potential of which is greater than that of the immediately overlying stratum, so that the potential diminishes from the surface of the earth to a minimum, to again increase at higher altitudes."

Concerning the luminous appearance caused by the "discharging apparatus," it is first to be noticed that the winter had been exceptionally mild, and, further that less than one-tenth of the usual number of auroras was reported, and these, except in three cases, were of feeble intensity. Lemström believes the cause of this diminution of auroral frequency, may be found in the constantly falling snow and the comparatively high temperature. The production of these artificial auroras was not so successful as could have been wished, but we are assured that a luminosity, sometimes in the form of cloud light, sometimes in the form of rays and beams, can be thus produced, and that it undoubtedly gives in the spectrum the auroral line.

A double Holtz machine was connected in circuit, and this luminosity was then easily obtained over the wires. A clear sky, low temperature and relatively low barometer are considered by Lemström as conditions necessary for successful production of this light. The results of the expedition are briefly summed up as follows:

1. The aurora borealis, which has long been a disputed enigma, is the result of an atmospheric electric current.

2. The aurora can be studied successfully by the methods adopted in this expedition.

3. The "discharging apparatus," or network of pointed conductors used by the expedition, has very often produced a diffuse light which gave in the spectroscope an auroral spectrum.

4. For the study of terrestrial currents a method has been found which, while avoiding all foreign influences, permits of the current being measured both as regards absolute strength and as regards the exact laws which regulate it.

5. From these experiments it seems that the existence of a belt of terrestrial currents similar to the belt of auroral currents is very probable. A. M.

DUST EXPLOSIONS.—Speaking about dust explosions, says the *Milling World*, a case from Germany is worthy of notice. A sack of flour falling down stairs, opened and scattered the contents in a cloud through the lower room, where a burning gas flame set fire to the dust, causing an explosion which lifted a part of the roof of the mill and broke almost all the windows. There can be no doubt that the majority of dust explosions are like mine disasters, due to open lights, and as this danger can be practically avoided by the use of the incandescent electric lights, there really seems to be no valid reason why it should not be introduced more generally, as those establishments which have used it express themselves in its favor. No matter how carefully other lights are guarded, an absolute safety, as long as the globes are intact, is offered only by the incandescent lamps, where the atmosphere or the dust has no access whatever to the flame. The above instance teaches also how little is necessary to start an explosion in the cleanest mill, so long as open lights are used; how much greater must the danger be in establishments where the air is constantly charged with dust, and where cleanliness is looked upon as of minor importance.

FLOOD SIGNALS.—The system adopted by the Government for the establishment of stations along the principal rivers, to note the rise and fall, and to give timely warning of approaching floods, is eminently a wise one, and will certainly prove a great blessing to those whose property is exposed to these sudden rises. Its benefits have already been felt to the people of our State along the Tennessee and its confluents. Stations are being established along the Cumberland, and in future we hope to be able to give, from time to time, tables of the stages of these rivers, which no doubt will prove very interesting and valuable additions to our reports. On this subject, we copy from the Chattanooga *Times* an interesting article explaining the workings of the system, to which we invite earnest attention.

When the Iron, Coal and Manufacturers' Association of this city instituted a system of flood warnings, they little knew what extensive proportions it would attain, and hardly conceived that it would become a feature of the signal service of the United States, and be operated under the patronage and protection of the Government. Yet such is the case. The system of flood warnings was inaugerated in this city in 1880, by the Iron, Coal and Manufacturers' Association. In previous years our city had been subject to overflows, which came without warning, and frequently were attended with great damage. Something was needed whereby sudden and dangerous rises could be foretold with some degree of accuracy, and this necessity first suggested a system of flood warnings. It was at first operated by voluntary agents. Stations were established at the principal river points above, extending as far as Saltville, Va. The results attained were manifestly so beneficial that the system gained recognition from the Government, and on this basis a general system of flood warnings was established, and has been introduced in modified form on the Sacramento river, the Mississippi, and is gradually being introduced throughout the Union. Congress, at its last session, appropriated $10,000 for this purpose.

The system under which it is operated on the Tennessee is, in brief, as follows: Observers are stationed at leading river points on direct lines of railway, and with telegraph facilities. They are supplied with all the necessary equipment and instruments to make observations and send mail reports to the observer at Chattanooga every twenty-four hours, giving the height of the river; the change in the past twenty-four hours; the depth of snow; the condition of the weather, and the direction of the wind. The observations are taken at 2 P. M., Washington time, about 1:30

local time. In case of a rainfall of two inches and in times of high tides, three daily observations are taken, and the result telegraphed to this city.

The following are the stations: Leadvale on the French Broad; Strawberry Plains, on the Holston; Knoxville, on the Tennessee; Loudon, on the Tennessee; Kingston, at the confluence of the Tennessee and Clinch; Charleston, on the Hiwassee. A station is also established at Soddy, and the observer authorized to telegraph in times of high tide when the river begins to fall, thereby giving our city eight to ten hours' notice.

The system, as now established, gives three days' warning of heavy tides. Its efficacy was demonstrated last year. On March 11th the river stood at forty-three feet, being the third highest tide reached. Our city was warned of the rise three days before it culminated, and thousands of dollars saved.

The system, as now perfected, embraces the entire valley of the Tennessee, and warning is sent the principal points below of threatened tides. Stations have been established at South Pittsburg, Samples, Ala., Guntersville, Decatur, Florence, Ala., and Paducah, Ky. The signal observer will send daily reports to the postmasters at these points, they having agreed to conspicuously post them; and when the water has reached within two feet of the danger line here, and is still rising, he is authorized to send special despatches to these points.—*Tennessee Weather Report for January.*

Musical Sands.—In Churchill county, Nevada, there is a traveling mountain of sand. The winds have gathered together a great heap and keep it constantly moving like an immense glacier. It crawls steadily along over valleys and through canyons, never ceasing, the sands making a low, musical sound as they rub against each other, much as they do around the Sphinx every morning at sunrise, which gave rise to the legend that the stony statue was greeting the morning sun with a song. But the moving mountain of Churchill contains still another peculiarity. While its sides are symmetrically formed and lay in folds like solidified waves there is no cone at the top. Instead of going to a peak there is a hole there, made by counter winds, and whoever is rash enough to scale the ridge and pass into that hole pays for his rashness with his life for the fickle sands yield beneath his feet, and the more he struggles to get back the faster he sinks, until he is smothered. The Indians tell of several of their tribe having been thus swallowed up, and no trace has ever been found of them since.—*Reese River Reveille.*

THE WINTER IN FLORIDA.—The lowest temperature at Jacksonville, Fla., last winter was 31½°, on the morning of Jan. 18. After the middle of December there were perhaps a dozen mornings in northern Florida on which there was a white frost. The dew is there very heavy, and the coating of frost is consequently thick—so thick that the sport of snow-balling could be fairly initiated where there were boards enough from which to gather the frozen dew with the palm of the hand. It looks strange on such a morning to see the full-bloomed roses crusted with frost, and see the frost change back to dew under the sun's rays, leaving the beauty of the flower unimpaired. The young orange shoots seem as tender as the frailest leaf that starts forth in the northern spring; yet there were only two frosts last winter that have nipped them, and these did not materially set back the young foliage in its growth. What orange-growers dread is not a frost, but a freeze. It was more than a frost winter before last when, early in January, the temperature fell to about 25 degrees, ice formed a quarter of an inch thick in buckets of water standing about the back yards, and the orange trees, after the sun had thawed out the leaves, looked as though a fire had swept through the groves. That was a freeze. The nearest approach to it last winter was once in January and once in February, when on clear, still nights a thin film of ice formed on water standing in favorable places. On those nights the orange trees were not frozen enough to injure them. The danger of a killing frost is usually past by the middle of February, as by that time the backbone, such as it is, of the Floridian winter is invariably broken.

REDUCTION OF BAROMETER READINGS TO LATITUDE 45°. A circular issued by the Signal Office announces that barometric observations, printed in its reports and on its maps will henceforward be reduced to standard gravity at latitude 45°. The reasons for this important and necessary step may be briefly presented as follows:

Let it be supposed that the solid earth has the form of a perfect ellipsoid of revolution. A quadrant of one of its elliptical meridians from pole to equator will then be everywhere at right angles to local gravity; gravity being the resultant of the earth's gravitation and its centrifugal force, and thus decreasing from pole to equator.

Next suppose a perfectly mobile liquid to rest on the rotating earth, under the action of no force but gravity. The liquid would

settle down into a quiet ocean, with its level surface everywhere at right angles to local gravity, and everywhere exerting the same pressure on the earth beneath; its depth would then necessarily vary inversely as gravity, and consequently be greater at the equator than at the poles.

If this liquid were mercury, and its depth at latitude 45° were 30″, then the depth at the equator would be 30″.08, and at the poles 29″.92. In the case of any other liquid or gaseous envelope, in static equilibrium around the earth, if it sustained a mercurial column 30″ high at latitude 45°, it would balance a column 30″.08 high at the equator, and 29″.92 at the poles.

This would be the case with our atmosphere, if it stood quietly on the ocean. If it were perfectly at rest, barometric readings would be higher at the equator than at the poles, although the pressures were alike. This difference of barometric readings would ordinarily be taken to indicate actual differences of pressure and effective poleward gradients; such as should cause winds. But this conclusion would evidently be erroneous, for barometric readings uncorrected for latitude are not directly comparable.

All isobaric charts should therefore be constructed according to barometric measures corrected for latitude, as well as for temperature and altitude. Until this is done, the poleward gradients will always appear steeper than they really are. Within the limits of the signal service charts of the United States, the correction would be about 0.07 of an inch; and this is as great as the temperature correction for 55° F., which no one thinks of omitting.

Observations of aneroid barometers of perfect construction would not need this correction, as their readings are dependent on the elasticity of metal, not on gravity; but they do need a correction to take account of the latitude in which they stood when compared with the standard mercurial barometer by which their scale was adjusted.

The relation of barometric readings at latitude λ to their equivalent at 45°, is as unity is to $1-0.0026\cos.2\lambda$. W. M. D.

MIGRATION OF BIRDS.—The Committee on Migration, appointed by the American Ornithologists' Union, report success in their efforts of last year, as appears from the following extract from their circular for 1885:—

The Committee on Bird Migration, during the first year of its existence (1884), distributed six thousand circulars, and in reply has received returns from more than a thousand observers. The area over which these observers are scattered is

co-extensive with the boundaries of the inhabited portions of the North American Continent, and includes parts of the West Indies, Central, and South America. Stations now exist in every State in the Union, and in every Territory except Nevada. Exclusive of Spanish America, the extreme points from which reports have actually been received will appear from the following statement: In the east, the southernmost station is Sombrero Key, off Southern Florida (latitude 24° 37′); and the northernmost, Belle Isle, off Labrador (latitude 51° 53′). In the west, reports have come to hand from Arizona and Southern California, and from Point Barrow, the most northerly point of Arctic Alaska (lat. 71° 18′). The easternmost station from which data have been received is St. John's, Newfoundland (west longitude 52° 45′), projecting well into the Atlantic; while on the Pacific the Committee has observers at various points in California, Oregon, Washington and British Columbia.

Hence it appears that the migration stations of the American Ornithologists' Union, exclusive of those in Spanish America, are sprinkled over 46° 41′ of latitude (approximately three thousand two hundred miles in a north and south direction), and 72° 15′ of longitude (approximately three thousand five hundred miles in an east and west direction). The distance in a straight line between the two most remote points (Sombrero Key and Point Barrow) is about four thousand three hundred miles.

They desire the aid of meteorologists on the following points:—

1. The direction and force of the wind.
2. The direction, character, and duration of storms.
3. The general conditions of the atmosphere including rainfall.
4. The succession of marked warm and cold waves, including a record of all sudden changes of temperature.

On contemporary and correlative phenomena they also wish aid. Some of these phenomena, as defined by them, are more or less regularly observed by meteorologists. The complete list is:—

1. The date at which the first toad is seen.
2. The date at which the first frog is heard.
3. The date at which the first tree-toad or 'peeper' is heard.
4. The dates at which certain mammals and reptiles enter upon and emerge from the state of hibernation.
5. The dates at which various insects are first seen.
6. The dates of the flowering of various plants.
7. The dates of the leafing and falling of the leaves of various trees and shrubs.
8. The date of the breaking up and the disappearance of the ice in rivers and lakes in spring, and of the freezing over of the same in the fall.

All reports are to be sent to C. Hart Merriam, M. D., chairman of Committee on Migration, Locust Grove, Lewis County, New York.

We note, *en passant*, that the work with which our ornithologists are occupied, seems to be an international one, as we find similar appeals in our foreign exchanges. From them we learn that 24 of the great states have their ornithological stations, and that these are scattered from Great Britain to Australia and Chili.

ENGINEER MELVILLE'S ARCTIC ENTERPRISE.—Mr. Melville thinks the pole should be approached from the side of Franz Josef Land, his plea for which is as follows:—

"The route I advocate is a perfectly safe one, both for advance and retreat. It has been explored for more than three hundred years; or since the time when Barrents made his last voyage, turning the north cape of Nova Zembla. His vessel, it will be remembered, was destroyed, but he wintered in safety in a house built of the wreckage, and his party made good their retreat to the coast of Norway, although the gallant old leader died of scurvy in his boat. There have been numerous voyages almost to within sight of Franz Josef Land,—notably that of Weyprecht and Payer, in the Isbiorn (Ice Bear), followed by their cruise in the Tegetthoff, when they discovered and charted the south end of Franz Josef Land, and after a march of but forty-seven miles, launched their boats and safely retreated to the coast of Nova Zembla, where they fell in with the Russian fishing fleet and were returned without loss to their homes in Norway.

"Later on, Leigh Smith, during his summer cruises in his steam yacht to the Arctic zone, landed on the southern end of Franz Josef Land, and, having enjoyed a pleasant season of hunting, returned in good spirits to Great Britain, partly paying his crew their wages from the profits of the chase. The ensuing year he revisited the scene of his successful sport, and essayed to reach a higher latitude by following up the west side of the land, where he should, and unquestionably would, have found the ice setting off shore, since it is well known to crowd upon the eastern coast. However, his vessel was destroyed. He saved his boats, some provisions, ammunition, and material enough to make tents and enable him to go into comfortable winter quarters. He killed sufficient game to sustain his party during the winter, and in spring launched his boats and made his way, without hardship or difficulty, to the coast of Nova Zembla, where he encountered the Russian fishing fleet, and was finally transferred to the Hope, (Sir Allen Young), a ship dispatched to his rescue by the British government.

"These expeditions, together with many fishing voyages not recorded, to the northeast of Nova Zembla, and in the vicinity of the southern end of Franz Josef Land, and around into the Kara sea, all tend to prove my assertion that this is a thoroughly safe and practicable route, and my assurance to this effect will be made doubly sure if the expedition I propose be properly provisioned and equipped for a long stay, advance, and retreat.

"The personnel of this expedition will consist of five officers and twenty-five men, equipped for four years. The work in all probability can be completed in two or three years, but the surplus supplies are intended for contingencies. There will be needed a ship of the size and build of the Thetis, of the Greely relief expedition, to carry a party of one officer and four men as far as Cape Nassau, at the northern point of Nova Zembla, where they will establish a depot of supplies for four years, and be provided with a boat, in which to retreat after a stay of three years, during which time they will be employed in taking a regular series of meteorological observations. Additional boats and the extra supplies will be left in reserve for the advance party, who will proceed by ships as far north on the west side of Franz Josef Land as they conveniently can, and then land with sleds, boats, house, and general equipment for a four years' stay.

Mr. Melville hopes for some Mecaenas or Grinnell, or Felix Booth to provide him with the money necessary. The total expense is

estimated at $130,000, and there must be many men in the United States who could, and might, give this amount.

THE USE OF OIL IN STORMS AT SEA.—This has now apparently passed from the experimental into the practical stage. We clip the following from the *Pilot Chart* for March:—

The Hydrographic Office has been collecting data to determine under what circumstances the use of oil is most efficacious in diminishing the danger of breaking seas during gales of wind.

Masters of vessels are requested to make experiments in this matter whenever the opportunity occurs, and report the results to one of the Branch Hydrographic Offices, or directly to the central Office at Washington.

When sufficient data have been collected a pamphlet will be issued giving such directions in regard to the use of oil as the common experience of seamen may determine to be the best.

The following accounts have been received lately:

During the passage of the U. S. schooner Ounalaska from San Francisco to Aleutian islands, between April 13 and May 20, 1884, oil was used in the following manner to modify the action of the sea:

A triangular sail, with a drop of six feet, was lashed to the steam cutter's mast, leaving about two feet of spar at each end. To the opposite angle of the sail was hung a 70-lb. boat anchor. From the three corners of the sail were led the lines which made the bridle, which was made fast to a four-inch hawser. A Navy clothes bag, punched irregularly with a needle, was partly filled with five gallons of lard oil, and the mouth sewed up. This was slung by a span from the ends of the mast so as to ride opposite to the center of it. The whole apparatus was put overboard with 65 fathoms of line, the schooner at the time being under a close reefed triangular mainsail. It tended three points off the weather bow, keeping the schooner within three or four points of the wind. The motion of the waves working the bag caused the oil to squirt out through the needle holes, so that the heaviest combing seas were immediately smoothed in coming in contact with the oil, and reached the vessel more like ground swells than waves due to a severe gale.

In 1881, Captain Black, of the British ship Lord Kinnard, was caught in a severe gale in the Baltic. He filled a canvas bag with oil and let it drag astern. The oil became thick like tallow, and did very little good. He then filled two woolen socks and hung them to the bumkins. The drippings from the socks soon reduced a heavy cross sea to a smooth swell, the sea no longer breaking.

The British S. S. North Anglia, from St. Jago, Cuba, to Philadelphia, on January 6, encountered a terrific gale. The vessel was brought head to wind, but the high seas broke over the rail and kept the deck flooded. Captain Mumford stationed a man in each closet forward to pour sperm oil down the pipes. This oil became thick as soon as it struck the water, and did no good. Oakum was then dipped into paint oil, and it was allowed to drip into the pipes. The decks then became as dry as in fine weather. The oil was used from 7 A. M., until 4 P. M.

Captain Mitchell, commanding the English steamer Mentmore, states that, on his voyage from Baltimore to Liverpool, during a heavy westerly gale, he used oil bags with remarkable effect. He hung one forward and one aft. The ship had been rolling heavily and taking large quantities of water on deck, but in a

few minutes, after placing the bags over the ship's side, she rode quite easily and shipped no more water.

In reporting the gale of August 29, 1883, the *Cape Ann Advertiser* says in regard to the experience of the schooner Sigfrid, Capt. Henry Thorpe: "The sea was the roughest the men ever saw, and they came near swamping several times. The oil in the butts and some kerosene oil was allowed to trickle overboard, which had a good effect in calming the huge waves and in rendering them powerless for danger."

Also, "Sch'r Mathew Keaney lost gear and had bulwarks stove in. A liberal use of oil did much to promote the safety of the vessel."

"Most vessels exposed to fury of storm, report great assistance in standing their force by the liberal use of oil."

A suitable method seems to have been devised for applying the oil, but no one seems to have studied the question of the best oil for the purpose. The individual oils must vary much in their power to still waves. This is a physical property which could be experimentally determined for each oil. This and the cost would settle the problem of the best oil. We may say, before leaving the subject, that this method of stilling waves is an old one. It seems to have been known to Theophylactes, a Byzantine historian of the sixth century. Bede's Historia Ecclesiastica, written in 720, gives an account of a royal wedding party that was saved from shipwreck by pouring oil on the waters. A priest had been sent into Kent to fetch King Edwin's daughter to be married to King Oswin. Before starting on the voyage he went to the bishop to have fair weather provided for the voyage. He was given a pot of oil to cast on the sea, accompanied by a prayer, in case the waves should become boisterous. As was feared they were caught in a heavy squall, and their royal ship was threatened with destruction. The oil was cast upon the seething waters. In a moment the white caps ceased to break, the deafening roar died away, and the sun shone out brightly. A number of other instances are cited where vessels were saved in a like manner. It was a common custom among sailors on the inland seas of Palestine before the Christian era, to oil the water in case it got too rough.

We saw, some time ago in the *Notes, Queries and Answers*, that Mr. G. Foster Howell, of the editorial staff of the *Nautical Gazette*, a marine journal published in New York City, was engaged in collecting material on the subject, and was writing a book which was to have been published the past year. Commander Bartlett has published an interesting account of recent experiments, in *Science* for January 16, 1885.

THE DEFLECTIVE EFFECT OF THE EARTH'S ROTATION.

GENERAL STATEMENT.—POISSON, 1838.—FERREL, 1859.—OTHER AUTHORS—ZÖPPRITZ' EXPLANATION.—EXPERIMENTAL ILLUSTRATION.—APPLICATION IN ANTI-TRADES.—HADLEY'S INCORRECT EXPLANATION, 1735.—TRACY ON ROTARY STORMS, 1843.—NO DIRECT CONTROL ON VELOCITY.—GENERAL EFFECTS.

The student of meteorology continually encounters examples of the effects of a deflective force arising from the earth's rotation, of greater or less importance in the study of the winds. The following pages are prepared with the hope of bringing a correct understanding of this force before the readers of the JOURNAL, and thus utilizing the notes taken on the subject by the writer for several years past, and perhaps helping others through the difficulties that have embarrassed him.

"In whatever direction a body moves on the surface of the earth, there is a force arising from the earth's rotation, which deflects it to the right in the northern hemisphere, but to the left in the southern." So wrote Ferrel in 1859. A body of mass M, moving horizontally without friction in *any* direction from a point whose latitude is φ on a planet of any size whose angular velocity of rotation is ω, will turn from its path with a force measured by $2\,Mv\omega \sin.\ \varphi$.

It is essential to notice that the direction or azimuth of motion does not enter this formula; the deflective force is therefore the same on motions in any direction from a given point. It is equally important to perceive that the deflective force always acts at right angles to the instantaneous direction of motion; it can therefore neither accelerate nor retard the motion.

The first correct and complete discussion of this force was by Poisson. The famous memoir, *Sur le mouvement des projectiles dans l'air, en ayant égard à la rotation de la terre*, was read in 1837 and published in the *Journal de l'École Polytechnique*, xvi, 1838. In this, after deducing his general equations (*e*), p. 21, from which the influence of the earth's attraction and rotation on the apparent motion of a projectile can be determined, he applies them to the case of a material point constrained to move on a given curve and attached to the surface of the earth, omitting the effects of friction and the resistance of the air. For this case the horizontal and vertical components of the deflecting forces, by which the point

will tend to depart from the constraining curve, are (the origin of co-ordinates being on the earth's surface, the axis of X being tangent to the local latitude circle and positive to the east, the axis of Y tangent to the local meridian and positive to the north, the axis of Z vertical and positive upwards; x, y, z, being co-ordinates of the point's path, and t the time of motion, n the earth's angular velocity of rotation per second, γ the latitude of the origin, and g the local gravity):

$$\text{On the axis of } X = 2n\left\{\frac{dy}{dt}\sin.\ \gamma - \frac{dz}{dt}\cos.\ \gamma\right\}$$

$$Y = -2n\frac{dx}{dt}\sin.\ \gamma$$

$$Z = 2n\frac{dx}{dt}\cos.\ \gamma - g.$$

For our problem, which is not given directly in Poisson's paper, probably on account of its simplicity, the constraining curve is a straight horizontal line through the origin, making an angle α with the axis of X. Then, letting v equal the relative linear velocity of the point, we have

$$\frac{dx}{dt} = v\cos.\alpha,\quad \frac{dy}{dt} = v\sin.\alpha,\quad \frac{dz}{dt} = 0.$$

Substituting these values in the above equations, they become

$$X = 2vn\sin.\gamma\sin.\alpha$$

$$Y = -2vn\sin.\gamma\cos.\alpha$$

$$Z = 2vn\cos.\gamma\cos.\alpha - g.$$

The third of these equations shows the effect that the horizontal motion will have on the weight of the moving body; decreasing it with eastward, and increasing it with westward motions, but with this we are not concerned. The resultant of X and Y is $2vn\sin.\gamma$ ($=2v\omega\sin.\varphi$ in our notation); this is independent of α, and acts to the right of and at right angles to the point's path, and hence is without effect on its velocity.

Ferrel's discussion of the question was first published in 1859 in Runkle's *Mathematical Monthly* (Cambridge, Mass.), in his celebrated paper on the "Motions of fluids and solids on the earth's surface." This has been reprinted with notes by Mr. Frank Waldo, as Professional Paper VIII of the Signal Service (see pp. 29, 30). Another demonstration by the same author is given in the *American Journal of Science*, 1861, xxxi, 27. These, being easily accessible, need not be further referred to here, as far as their method is concerned; but it should be said that they contain the first quantitative esti-

mates of the effect of the deflective force in its meteorological applications.

English readers will probably be more familiar with the treatise by Routh on the "Dynamics of a System of Rigid Bodies" (3d ed., 1877), which considers motions relative to the earth (page 213), and, after deducing general equations for projectiles, discusses the case of the motion of a body constrained to remain in a plane fixed in regard to the earth, and hence rotating with it (p. 220). If the plain make the angle θ with the earth's axis, the tendency to a right-handed deflection is found to be $2\,Mv\omega\sin.\theta$. If the plane be the horizon plane, then $\theta=\varphi$, and the result agrees with that given above.

References to other competent discussions of the subject are given by Mr. Frank Waldo, of the U. S. Signal Service, in the *Philosophical Magazine* for October, 1883; and an interesting popular history of the question, with a good list of authorities, by Günther, appeared in the German journal *Humboldt* in 1882. Recently a simple demonstration was prepared by Dr. Sprung for the German *Meteorologische Zeitschrift*, 1884. But of all the explanations that have appeared, the following, based on a paper by Professor K. Zöppritz, seems the most accessible to non-mathematical readers, and has therefore given me the most satisfaction.*

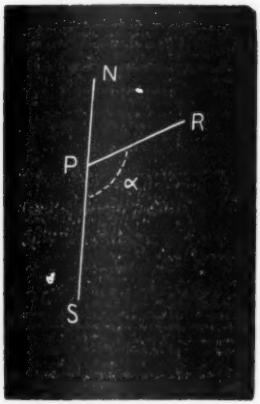


FIG. 1.

Let us consider the motion of a body A of mass M, moving without friction at a velocity of v feet per second in a direction that makes an angle α with the meridian from the point P (fig. 1). At the end of one second A would reach R if the earth were at rest; but during this second, the earth's angular rotation has turned an equatorial radius to the left through the angle ω, and has consequently turned the meridian at P through the smaller angle $SPS'=\omega\sin.\varphi$

* This opportunity may be taken to say that the form of explanation that I prepared for Van Nostrand's *Engineering Magazine* (1883, 297) was very seriously incorrect.

(fig. 2). The line PR, which at the initial moment marked the direction of A's motion, must also turn through the angle $\omega \sin. \varphi$, because it is a fixed line on the earth's surface, making a constant angle with the meridian. Being unaffected by friction, A will not turn aside with PR, but will persevere in its original direction, and at the end of a second will be found at T. An observer on the earth, accustomed to regard his meridian, or a line like PR, as fixed, will interpret the displacement of A from R to T as a tendency to depart to the right of its original direction. So long, then, as lines on the rotating earth are regarded as fixed standards of reference for frictionless motions on its surface, it is proper to speak of a "deflective force arising from the earth's rotation;" but, evidently, this force arises simply from the tendency of a moving body to advance along a straight line, while lines on the earth are continually changing their absolute direction in virtue of its rotation.

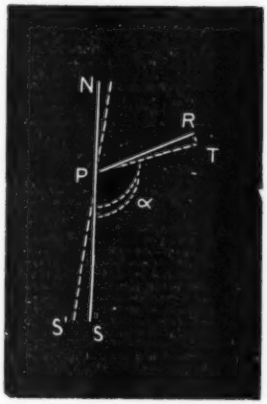


FIG. 2.

To obtain a measure of the deflective tendency, we note that in one second A has moved to the right of its original path over a distance $RT = v\omega \sin. \varphi$, in obedience to a continual right-handed accelerating force. Then, just as in the case of gravity, the velocity attained at the end of the first second would, if maintained uniformly, carry A over 2 TS in the next second; and the velocity thus attained in a second is a measure of the deflective force, which therefore is $2v\omega \sin. \varphi$.

If south latitudes be considered negative, the deflection in the southern hemisphere will be negative or to the left. The equator is the only line along which a body can move without changing its direction, for the sine of the equator's latitude is zero.

It is not easy at first to conceive of the continued deflection of the line PT; but an experiment with an ordinary globe will suffice to make it clear. Cut out several circular paper discs, an inch or so in diameter; draw a black radial line on each one and attach them to the globe in various latitudes, with the radial mark in any accidental attitude. Now place the eye in line with the globe's axis, so as to look upon it as if from the North Star, and then turn

the globe slowly from right to left; all the radial marks will be seen to change their direction very distinctly as the rotation goes on: the disc nearest the pole will turn fastest, and nearest the equator, slowest. Every disc may therefore be regarded as a whirling table, with an angular velocity $\omega \sin.\varphi$; and a body moving outward from the centre of such a table will of course leave the radius on which it started and turn to the right with respect to the table in whatever direction the movement begins.

One of the simplest, and at the same time most important, applications of the deflective force may be seen in the overflow of the anti-trades north and south from the meteorological equator. A very slow ascent of the confluent trades* carries the air to an altitude where the isobaric surfaces slope poleward; gravity then gives the air a faint acceleration, which results in a poleward motion. The deflective force is weak in these low latitudes, but friction is so small that the effect of the deflection becomes very apparent between 5° and 10° from the equator, and the overflow turns strongly to the eastward (see this JOURNAL, p. 52, June, 1884). Now the air, sliding obliquely down the poleward gradients, moves under the action of two forces. The component of gravity in the plane of the gradient, CG (fig. 3) urges it poleward; but poleward motion

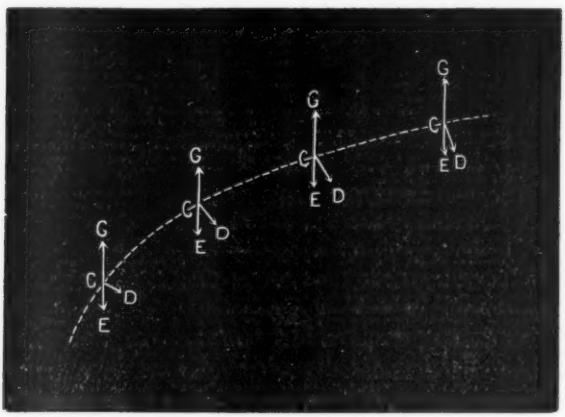


FIG. 3.

* The mutual approach of the trades and the recession of the anti-trades is enough to prove the existence of an ascending current about the doldrums; but as the cross-section of this current is much greater than that of the trades which supply it, the principle of continuity demands that the ascending current shall be very slow. It is probably further complicated by the numerous thunder-storms of the belt of calms.

is retarded by the equatorward component, CE, of the deflective force, CD (resolved in the direction of motion and along a local meridian); and CE becomes larger and larger as higher latitudes, greater velocity and more nearly eastward motion are gained. If there were no friction, there might at last be almost a balance attained between the two opposite forces, and this would result in the winds moving nearly due east at an almost constant, moderate velocity. But there must be some friction which will continually consume some of the momentum and diminish the eastward velocity, and consequently lessen the equatorward deflective force, while the poleward acceleration remains as powerful as before (supposing the gradients remain the same). The poleward force would then have a slight excess over its opponent, and in obedience to this a slightly poleward direction will be followed by the wind. As a matter of fact, therefore, the balance between the opposing forces is never reached, although closely approached; the air moves very obliquely across the meridians under the control of a very small residual accelerating force, and hence (as Ferrel has shown, *Amer. Jour. of Sc.*, 1861, May,) at a moderate velocity compared with the violence of the convectional circulation that would be attained if the earth stood still. The effect of the deflective force in making the barometric pressure much higher in the torrid zone, and much lower about the poles, than it would be if determined simply by differences of temperature and moisture, follows from this consideration, and is one of the notable discoveries of modern deductive meteorology.

In spite of the time that has passed since Poisson and Ferrel showed the true value of the deflective force, the incorrect or rather the incomplete statement that originated with Hadley, in 1735, still remains current in most scientific text-books. Hadley's paper, "Concerning the cause of the general trade-winds" in the Philosophical Transactions for 1735, p. 58, refers only to the excess of rotary velocity in the lower latitudes, and the consequent running ahead to the east in poleward motions and the lagging behind to the west in equatorward motions. This explanation would not imply any deflection for motions to the east or west, and therefore represents only part of one element of the total deflective force. It was, however, a great discovery, although an incomplete one, and vastly superior in its application to the trade-winds to Halley's erroneous theory of fifty years earlier date. Dalton notes in his "Meteorological observations and essays" (1793) that Hadley's theory

had been forgotten through the greater part of his century, and revives it with approval. De Luc had already suggested the same explanation independently in 1779, and since Dove made it popular (1835), it has generally been accepted in scientific writings. It is repeated more or less closely in the books on meteorology or physical geography, by Ansted, Buchan, Flammarion, Geikie, Guyot, Herschel, v. Klöden, Laughton, Ley, Loomis, Maury, Page, Peschel, Reclus, Schmid, Somerville, and Young. The complete statement is seldom found; but it is approached in Scott's *Meteorology*, and is correctly given by Blanford in his admirable essay, "The Indian Meteorologists' Vademecum" (part II, 1877, 68) and accredited it to Ferrel; in Mohn's "Grundzüge der Meteorologie," and in "Hann's "Meteorologie," (making part of the "Physische Erdkunde" by Hann, Hochstetter, and Pokorny, Vienna, 1881). Doubtless it is to be found in other books of late date, for in Germany especially it has received a good share of attention.*

Reference should be made also to Tracy, who first after Poisson showed the true quality of the deflecting force and its variation with the sine of the latitude, in an article that has been singularly neglected ("The rotary action of storms," *Amer. Journ. of Sci.* XIV 1843, 65–72; see *Science*, I, 1883, 88); and to Taylor (*Brit. Assoc. Rept.*, 1852. pt. 2, 31), who is referred to by Herschel as giving the first explanation of the rotation of storm-winds. But scanty justice was done to Taylor in the reference, for Herschel explicitly denied the deflection of east and west winds, while Taylor evidently implied it in his statement that "the area of the whirlwind is turning round with regard to its own centre."

It is worth while to state explicitly the reasons why Hadley's explanation is incorrect. In the first place, it requires that there should be no deflection of motions along the parallels of latitude. In the second place, it implies that a large share of the trade-wind's velocity is due to "lagging behind." Finally, as generally stated, it admits the impossible supposition that a body moving southward from latitude 30° N. could continue moving southward till it reached the equator. All this is wrong, and its correction implies a considerable change in our methods of teaching this part of elementary meteorology. East or west motion is deflected just as well as north or south. The wind's velocity comes essentially from its gravitative acceleration down effective gradients, or from

* Since writing the above, I have seen Günther's excellent *Geophysik*, where this question is well presented.

forces brought into play by gravity, and not at all from "lagging behind," as that term is ordinarily used. And a body moving southward is (theoretically) turned to the right at every foot of its advance; if it begin to move without friction, and with a velocity due only to its initial impulse, it will move always with the same velocity, although continually changing its direction; it will cross the equator very obliquely, but still moving at its original rate, far west of its initial meridian. The velocity of motion is unaffected by the deflective force because the latter is always at right angles to the former. Any increase in velocity must therefore be due directly or indirectly to gravitative acceleration, and be independent of the earth's rotation.

The error of supposing that the rotation of the earth determines the velocity of its winds, in virtue of their "lagging behind," is as serious as that which limits the deflection to meridional motions. On account of the small velocity that the winds actually possess compared with that which Hadley's theory would give them, Laughton concludes that the friction between the air and earth is so great that no sensible deflection can be permitted, and hence he ascribes the various turnings of the winds to other causes. On the strength of this and other arguments he doubts whether cyclones are constant in their direction of turning, and finally decides that "it would be contrary to all direct evidence to admit that the rotation of the earth produces any sensible effect on that motion of the air which we call *wind*." (*Physical Geography*, 1873, 127, 358). And even Herschel wrote, "Of all the winds that occur over the whole earth one-half at least, more probably two-thirds, of the average momentum is nothing else than force given out by the globe in its rotation in the trade currents, and in the act of re-absorbtion or resumption by it from the anti-trades," (*Meteorology*, 1861, 57), and this probably expresses the general belief on the question; but it cannot be true. Our westerly winds have gained their velocity from gravitative acceleration along effective gradients, and owe only their direction to the rotation of the earth. Indeed, Ferrel's investigations, already alluded to above, show that the general planetary circulation of the atmosphere, of which the trades and westerlies are the chief lower members, would be more rapid if the earth were standing still (supposing it to retain its present torrid and frigid zones of temperature) than if it were rotating; because, when rotating, the deflective force prevents the difference of polar and equatorial atmospheric densities from exer-

cising its full effect in bringing about winds. It is therefore questionable whether a former faster rotation of the earth alone would make itself apparent in producing trades and anti-trades of greater strength than those we know, as has been supposed. Storms might have been more frequent then, but the general atmospheric circulation would have been only "flattened" into more nearly east and west motion, not strengthened to a greater velocity.

The following table gives the force in fractions of gravity with which a free moving body will tend to turn to the right in the northern hemisphere, or to the left in the southern, at various latitudes and for various rates of motion. It is calculated from Ferrel's formula $\frac{v \sin. \varphi}{150{,}000} g$ (in which v is the velocity in miles per hour).

Latitude.	Miles an Hour.			
	10	30	50	100
20°	0.00,002 g	0.00,007 g	0.00,011 g	0.00,023 g
40°	4	13	21	43
50°	5	15	26	51
70°	6	19	31	63

Among the effects of the deflective force that have been noticed by various authors there may be mentioned:—The change in the plane of oscillation of a long, free-swinging pendulum; the oblique motion of the trade-winds and the general easterly flow of the winds in temperate latitudes; and hence, indirectly, the high barometric pressure about the tropics and the remarkably low pressure in the polar, especially in the Antarctic regions; the constant direction of rotation of cyclonic storms, and in a limited way their recession from the equator, and indirectly a share of their strength; indirectly, the left-handed turning of tornadoes; the regular circulation of the great oceanic eddies and the formation of the so-called Sargasso seas at their centres; an effect on the form of certain river valleys; a small element of inaccuracy in artillery target practice; and the doubtful but possible faster wearing of the right-hand rail on double-track railways.

Cambridge, Mass. W. M. Davis.

THE KHAMSIN AND OTHER DESERT WINDS.

In view of the campaign in the Soudan region, and the trials which the next few months have in store for the English army there, the winds and storms of the country are of especial interest.

The following from the pen of the late J. Keith Johnston is not only interesting, but reliable:—

"Africa is not much under the influence of the regular winds, except the monsoons of the Indian Ocean; the great movement of the atmosphere depending chiefly on the oscillation of the continent beneath, during the seasons. The wind currents over the whole continent have a prevailing direction from the east. These are trade-winds modified by interruptions of changing heat and elevation of the land surface.

"In the northern part of the Indian Ocean the year is divided between the southwest monsoon, blowing from March till September away from Africa toward the then heated continent of Asia, and the northeast monsoon, or rather the normal trade-wind, blowing toward the African coast from October to February.

"The monsoons, although they extend only to about a third portion of the east African shores, have an extremely important bearing upon the physical economy of the whole African continent.

"From hurricanes Africa is nearly exempt, except in its southeastern extremity to which, at times, the Mauritius hurricanes extend. At rare intervals these have visited the east coast as far as Zanzibar.

"Northern Africa is much exposed to the hot winds and storms from the Sahara, which are called in Egypt, Khamsin, in the Mediterannean, Sirocco, Shume or Asshume in Morocco, and Harmattan on the east coast of the Sahara and in the countries bordering on the Gulf of Guinea. These always blow directly across the coast from the interior, and seem to move around the compass during the year, beginning in Egypt in April, in Algeria in July, in Morocco in August, and in Senegambia in November. Similar dry electrical winds prevail in the Kalahari desert in the south.

"Extreme heat and dryness are the characteristics of these winds, which, raising the sand, filling the air with dust and pro-

digiously favoring the process of evaporation, are often fatal to vegetable and animal life in the regions visited by them. In Africa the dependence of the winds and rains upon the movement of the land beneath the sun is more clearly marked than in any other intertropical region of the globe. The high temperature caused by the vertical heat of the sun over a particular area induces an indraught of air to that place, an ascending current is produced which carries up with it the warm and moist air: condensed in the higher regions of the atmosphere, the moisture falls as rain, and the condensation makes way for a further indraught.

"It is thus that in Africa the winds and rains follow the pendulating movement of the continent beneath the sun, and the rainy season of any space begins almost immediately after the sun has reached its zenith.

"In the northern and eastern regions of Africa the winds and rains are governed as much by the heating and cooling of the Asiatic continent, as by that of Africa."

The Khamsin usually begins twenty-five days before the spring equinox and continues twenty-five days after it. The exceeding dryness of these winds would lead one to suppose them to be very unhealthy, but that is not the case. It is said that intermittent fevers are cured by their first breath; and that all epidemic diseases disappear as if by magic. It is even said to be impossible to communicate infection even artificially during their continuance. (Flammarion.)

The accounts which have been current for years concerning the terrors of the desert—the pestilential character of its winds, its poisonous serpents, etc.,—all seem to have been exaggerated.

The natives had every reason to discourage strangers from penetrating into the interior, and merchants, who had crossed in safety, countenanced the exaggeration to prevent competition.

At the same time there is no doubt that a *simoom* is the worst form of disaster which could overtake a caravan or an army: but it is entirely different from the Khamsin. "The simoom," says Palgrave, "is a peculiar condition of the atmosphere resembling a cyclone. As in the cyclone the central space, or the simoom itself, is calm, but is occupied by a gas unfit for respiration, while round this as a center, slowly travelling on, there eddy violent gusts of heated air like those of a furnace, though it is not to them but to the comparative vacuum which they surround that the simoom owes

ts suffocating qualities. It approaches slowly amid the whirl of air-currents that precede it for some distance; its violet color announces it when actually near. During its presence, the only chance of preserving life till the mephitic vapor has passed over, is found in covering the face with a cloth and lying prone in the sand, thus to inhale what little atmospheric air still exists in the upper ground stratum, and thus to maintain the breath till this period, varying from two to ten minutes, of the poison column is gone by; meanwhile the feeling in the chest is that of suffocation, and that in the limbs as if molten iron were being poured over them. Camels instinctively bury their muzzles in the sand during the simoom; but horses are said not to possess the same preservatory instinct, and to perish in consequence. The precise nature of this phenomenon, and its origin are subjects of conjecture, but its general character, that of an eddy of heated atmosphere around a central space occupied by deleterious gas, the whole travelling at a slow rate, and generally from south or east to north and west, is not to be mistaken."

The horrors of the real simoom, then, can scarcely be overestimated. Its continuance for fifteen minutes is supposed to be fatal to all life, but the ordinary duration is from five to ten minutes, and it would seem that frequent disasters could be avoided by taking the proper precautions.

In 1815, a great caravan, consisting of 2000 men and 1800 camels, went into the Sahara and disappeared completely. In 520 B. C., after Cambyses conquered Egypt, he sent an army of fifty thousand men into the desert to destroy the Temple of Jupiter Ammon. They were never heard from afterward, and their disappearance is attributed to the simoom.

These fierce winds are most common near the time of the equinoxes.

Ismail Pasha and Rehib Pasha, who are both in London, advise that further operations in the Soudan be postponed until autumn, as an expedition from Suakim in March would only court the fate of the army of Cambyses. R. H.

A LATELY DISCOVERED METEOROLOGICAL CYCLE.

NO. II.

For a clear understanding of the present article, it will be necessary to refer the reader to a preceding article given in vol. I, No. 4 (Aug. '84) of this JOURNAL. The contents of that article were, however, briefly as follows:

It was shown that, if the monthly barometric means for widely separated stations (such as St. Paul, Minn., and Portland, Oreg.) were taken from the Signal Office reports and smoothed by getting the means of every consecutive twelve of them, curves drawn from the numbers thus obtained exhibited on the whole a large oscillation corresponding with the eleven year oscillation in the number of sunspots. Besides this, shorter oscillations were visible in the curves, occupying twenty-five months in their completion. If, however, the monthly means were smoothed by getting the means of every twenty-five consecutive months instead of twelve, the shorter oscillations were no longer visible; and if the numbers thus obtained were used in constructing curves on the same paper as the first, the first curves would be during twelve and a half months on one side, and during the next twelve and a half months on the other side of the last curves. If the numbers from which the last curves were drawn were subtracted from those from which the first curves were drawn, it would consequently give a series of numbers in which about twelve consecutive numbers with (+) signs attached would be followed by about twelve with (−) signs attached. These numbers I have supposed to represent the deviations of a twenty-five months' cycle from a mean.

The largest numbers with (+) signs attached were usually those about the middle of each series of (+) numbers, and the largest numbers with (−) signs attached were usually about the middle of each following series of (−) numbers. We will hence call the middle of the former series the periods of maximum (+) deviation; and the latter, the periods of maximum (−) deviation. These periods occurred in Dec., 1874, Dec., 1875, Jan., 1877, Feb., 1878, March, 1879, and March, 1880. It was also shown in my first article that the rainfall and temperature went through oscillations coincident with those of the barometer. All of the curves representing the barometric oscillations given oscillated in a similar

manner; but if a curve constructed in the same way for Boston had been added,* it would have shown after 1875, oscillations in a diametrically opposite phase to those of the other curves. Hence a time of maximum (+) deviation at St. Paul was a time of maximum (—) deviation at Boston, and *vice versa*. Curves for certain points between St. Paul and Boston were irregular, showing scarcely any traces of periodicity.

The variations of the twenty-five months' cycle, as explained briefly above and more fully in my first article, were worked out for sixteen stations as evenly distributed over the United States as possible. The numbers thus obtained were not considered to fully represent the actual amount of variation of the pressure, since the process of smoothing by which the variation was rendered apparent tended to lessen the amount. To ascertain how much it was decreased by this process, several columns of the numbers obtained were smoothed by getting the means of every consecutive twelve, and it was found that the numbers thus obtained had to be increased by one-half in order to make them equal to the first numbers. It thus seemed proper that the first numbers should be increased by one-half in order to obtain the true amount of the oscillations of pressure during the twenty-five months' cycle.

This was done, and from the numbers thus obtained curves were constructed, and the amounts they deviated from the mean (or datum line) at the time of each maximum (+) and maximum (−) deviation (Dec., 1874, Dec., 1875, etc.) were obtained by measurement. This was done because there were small irregular variations in the numbers themselves, and these could be eliminated in drawing the curves. The numbers obtained in this manner are given in the accompanying table.

It will be seen by a glance at this table that, in Dec. 1874, in the eastern part of the United States, the greatest deviations in a plus direction occurred at Buffalo, which gave a deviation of +.030. Around this is found a ring of stations—Boston, Washington, Louisville, St. Louis, St. Paul and Alpena—giving deviations in the vicinity of +.020; while Denver and Mobile, farther to the west and south, show scarcely any deviations; and Shreveport and Santa Fe, still farther to the southwest, show deviations in the opposite direction. Glancing at stations still farther to the west, as Virginia City and San Francisco, increasing deviations are evi-

* I regret that the curve for Boston was not added to the first article, but I thought at the time it was best to leave it out for several reasons; one of which was, I was endeavoring to be brief, and the explanations necessary would have considerably lengthened my article.

dent, until at Portland another point of maximum deviation is found. Glancing down the column for Dec., 1875, the points of

	Dec. 1874.	Dec. 1875.	Jan. 1877.	Feb. 1878.	March. 1879.	March. 1880.
Boston	+.018	.000	−.026	+.006	−.024	+.033
Buffalo	+.030	−.018	.000	−.017	−.007	+.004
Washington	+.024	.000	−.022	−.011	−.015	+.026
Charleston	+.015	+.012	−.020	−.025	.000	+.020
Mobile	+.006	+.003	−.002	−.033	+.018	+.010
Louisville	+.023	−.020	+.013	−.052	+.034	.000
Alpena	+.015	−.030	+.022	−.035	+.015	−.010
St. Paul	+.018	−.030	+.035	−.050	+.038	−.040
St. Louis	+.024	−.030	+.022	−.052	+.045	−.015
Shreveport	−.023	.000	+.024	−.052	+.032	−.008
Santa Fe	−.020	+.016	.000	−.020	+.020	−.002
Denver	.000	−.003	+.010	−.020	+.028	−.020
Virginia City	+.018	−.020	+.020	−.015	+.028	−.025
Portland, Oreg.	+.045	−.030	+.022	−.048	+.030	−.001
San Francisco	+.010	.000	−.002	−.022	+.015	+.015
San Diego	+.002	.000	.000	−.016	+.005	+.020

greatest deviation are found in the same vicinities, but in opposite phases. The numbers obtained for each period as given in the table were placed on maps in their proper places, and lines for deviations of every .010 inch were drawn. These are shown on the accompanying maps. Continuous lines show plus deviations, and broken lines minus deviations. The maps on opposite sides of the page show the cycle in opposite phases. This see-saw oscillation of the pressure from a maximum to a minimum and from a minimum to a maximum on each side of a line of no variation, which is shown by the maps, remind one of the loops and nodes found in a disk vibrating with sonorous vibrations.

It will be noticed that the centers of greatest deviation have slightly different positions on the different maps, there having been on the whole a westward movement of the centers. On the last

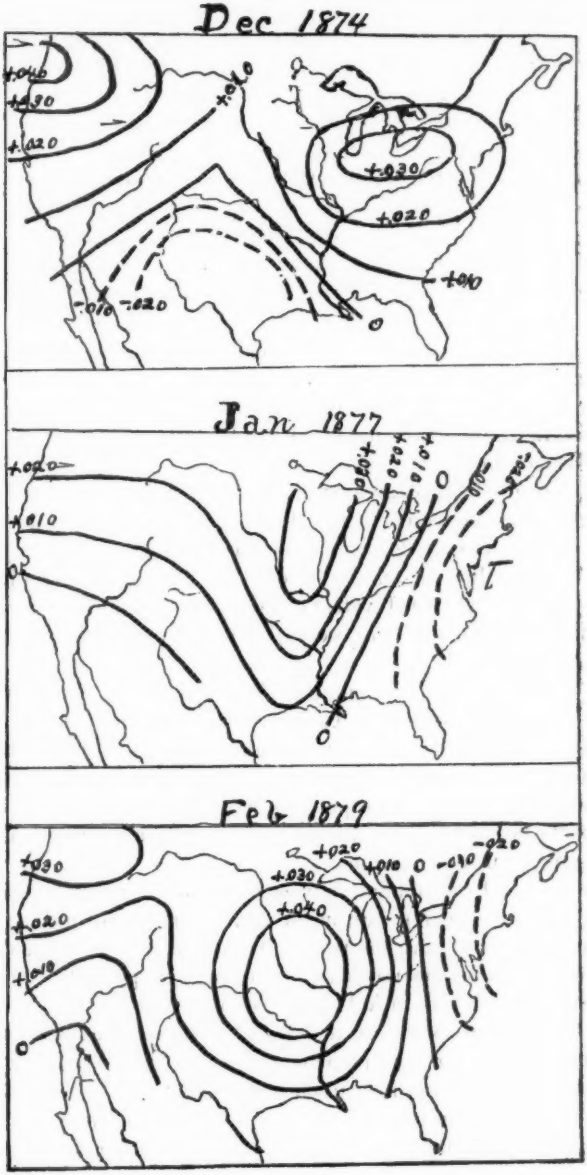
chart, little circles are drawn in the position occupied by the center of greatest deviation near the middle of the continent, at each period. The dark line or arrow connecting these show the movement of the center.

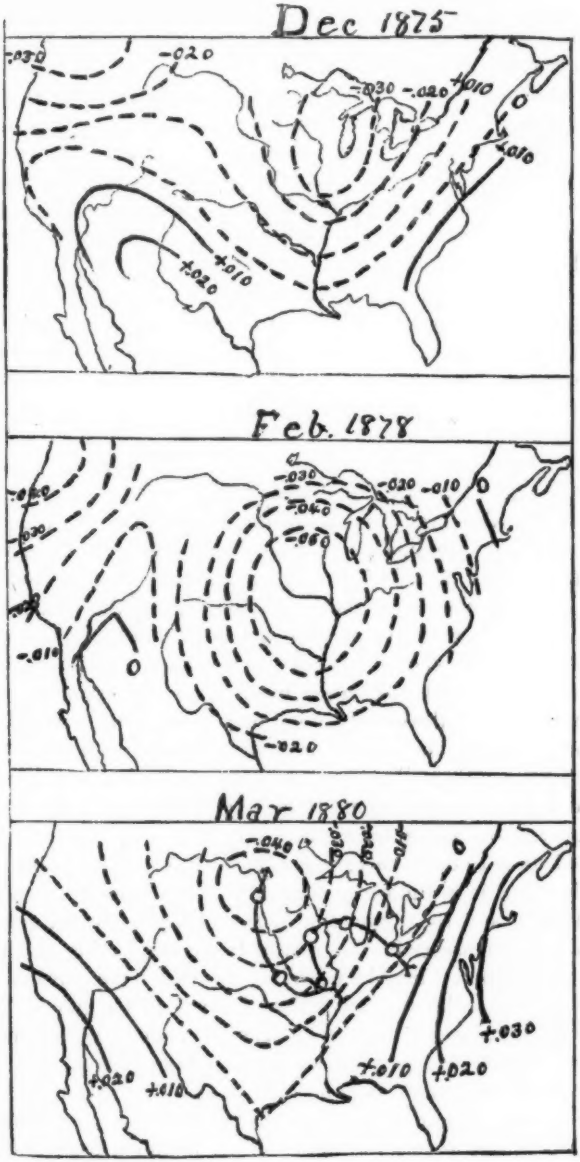
I will also state that data in my possession have led me to believe that in the United States during the last forty years there has been a well defined oscillation of the pressure, corresponding in length to the oscillation in the number of sunspots, and showing distinct centers of oscillations like those represented on the maps of the twenty-five months' cycle. At some points the pressure consequently oscillated in the same manner as the number of sunspots; and at other widely separated points in an opposite manner; while at points between there was no oscillation, or the oscillation was now with, now against the sunspots, corresponding with movements of the centers of oscillation. If this be true, it answers an objection urged by Gröben against the existence in America of any periodicity in the rainfall corresponding to the sunspot cycle, because an examination of the amount of water discharged from the mouth of the Mississippi failed to show any such periodic oscillation. I have reason to believe that during part of this time oscillations in the amount of rainfall were in opposite directions near the head waters of the Missouri and Ohio rivers, so that the indications of any oscillation at the mouth of the Mississippi might have been nil.

If Engelman's rainfall numbers for St. Louis be taken, and the yearly means be smoothed by getting the mean of every consecutive five (or better the quarterly means be smoothed by getting the mean of twenty), and a curve be constructed therefrom, oscillations are obtained exactly corresponding with the sunspots up to 1866 when the curve began to change, and in 1872 a minimum instead of a maximum was exhibited.

As soon as I can obtain the necessary time and data, I intend to undertake the working out, in the manner indicated in this article, the oscillations of both the twenty-five and eleven year cycles over as large a part of the northern hemisphere as possible. When I have completed this task I shall feel in a position to apply, as a final test of their existence, the crucial test of prediction.

After presenting my first article, I learned that one or two able meteorologists did not look upon it very favorably. I wrote to one of them concerning it, and he replied:—"I should take care not to deny the possibility of your cycle or almost any other; but the


Dec 1874
+040
+030
+020
+010
+030
+020
+010
-010
-020
0
Jan 1877
+020
+010
0
+030
+020
+010
0
-010
-020
Feb 1879
+030
+020
+010
+020
+030
+040
+010
0
-010
-020
0


Dec 1875
-.030
-.020
-.030
-.020
+.010
+.010
+.020
+.010
Feb. 1878
-.030
-.020
-.010
-.040
-.060
-.010
-.020
Mar 1880
-.040
+.030
+.020
+.010
+.010
+.020

evidence for it is not satisfying, because it does not appeal to the reason; you can see no meaning in it, even if you see pretty strong evidence of occurrence."

I will admit that I am unable to explain the cause of my cycle, but if every discovery that could not be at once explained by known laws, or did not immediately fall into line with what had been previously ascertained, had been rejected in the history of scientific research, then we should have lost some of the fairest flowers of modern science. There was no reason whatever known why Kelper's laws should exist when he discovered them, in fact they were at complete variance with all that had been before thought on the subject, and Kelper never knew any reason for them; but Newton came, and showed them to be the necessary consequence of the action of certain universal laws. There is no known reason why the number of sunspots should go through a cycle of about eleven years, or why there should be a connection between them and terrestial magnetism, but there is scarcely a scientific man of repute that doubts it.

My critic also urges as an objection that "there is too great a possibility of approximate agreement" as the result of mere chance.

That during a period of eight years the pressure at widely separated stations should go through coincident oscillations approximating about twenty-five months in length, and that the temperature and rainfall should also show coincident oscillations, might possibly be the result of chance; but that sixteen stations separated by hundreds of miles should unite in showing certain distinct centers of oscillation, and should unite in showing during a number of successive periods well defined motions of these centers; and all be the work of chance seems to me incredible, and I can scarcely see how any one can entertain it.

But I do not object to criticism, for I feel that the honest and intelligent critic is almost as necessary in scientific research as the investigator, and the dominating desire of my heart and motive of my labors is to ascertain the truth. In accomplishing the task I have marked out, it may be necessary to make some personal sacrifices; and in adjusting my actions I want to be guided by the clearest light, for the history of science, while it shows that the greatest results have sometimes been obtained empirically, also shows that men may easily deceive themselves; so that I shall welcome and carefully consider the criticism of any who may entertain doubts as to the accuracy of my methods and results.

H. Helm Clayton, Jr.

DR. DRAPER'S INSTRUMENTS FOR RECORDING THE DIRECTION, VELOCITY AND FORCE OF THE WIND.

Instrument for Recording the Direction of Wind.

From the wind vane placed several feet above the roof descends a vertical shaft, to the lower end of which is fastened a brass cylinder, which carries a register sheet of paper to receive the oscillations of the wind, A pencil bearing lightly against the paper descends from the top to the bottom of the cylinder in the course of twenty-four hours; its movements are regulated by a clock. When the wind shifts the paper register therefore correspondingly turns, and the pencil makes a trace of the movement; if the wind has ceased the pencil makes a straight line downwards. On the sheet of paper are printed lines for the four cardinal points, N., E., S., W., and the hours of the day, the trace thus showing the direction and all the variations of the wind, and the time of their occurrence.

DESCRIPTION OF INSTRUMENT.

The wind vane, *a a*, 15 feet above the roof of the building, the vertical shaft, *b b*, which is fastened to and turns with the vane, and gives corresponding movements to the brass cylinder, *c c*, round which the register paper is fastened. At *d*, is a pencil tube attached to the top of the weight *e*, and the pencil bears lightly against the paper by an India rubber elastic spring.

A clock, *g*, permits this weight to descend to the bottom of the cylinder in twenty-four hours, when the cylinder is taken out, and the register slipped off. Another one is put on by pasting one of the edges of the paper and letting it overlap the other edge round the cylinder.

Instrument for Recording the Velocity of the Wind.

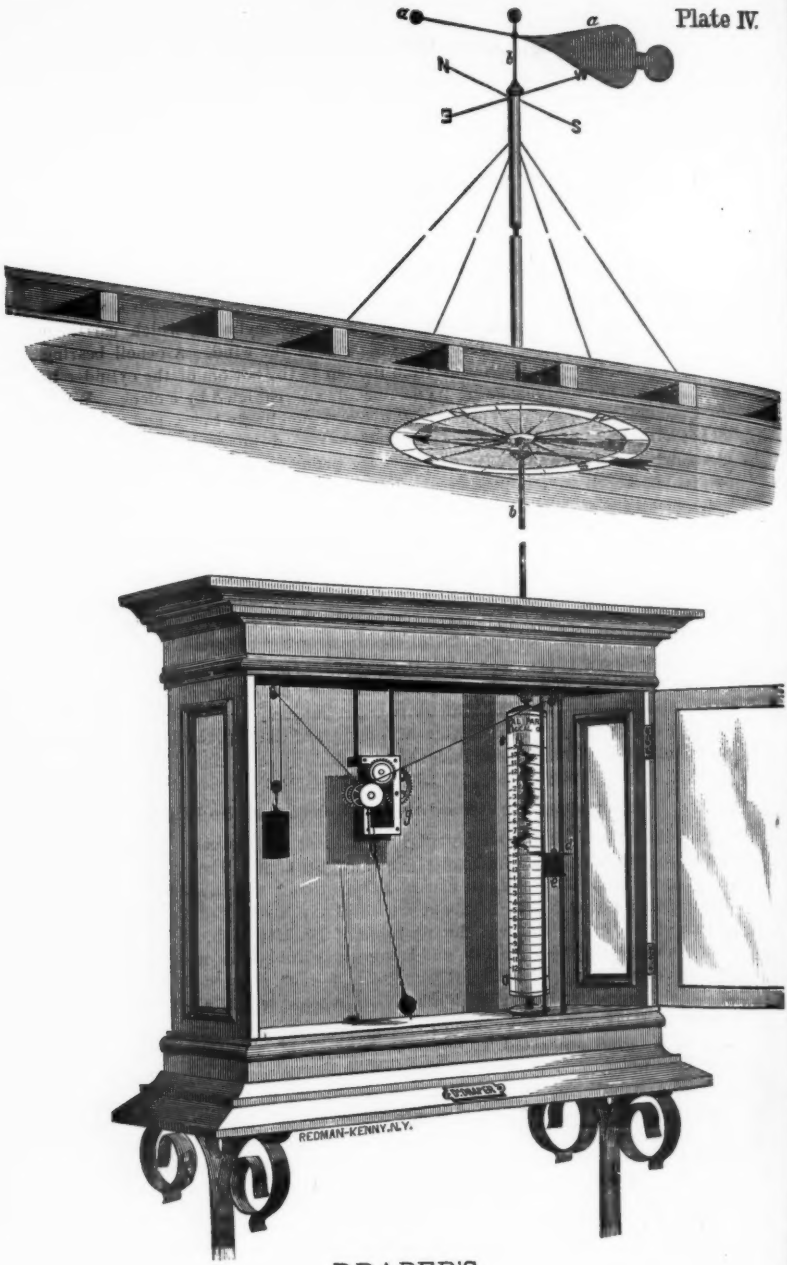
On the ends of a cross supported by a vertical shaft several feet above the roof of the building, are four hemispherical copper cups. These, whatever may be the direction of the wind, are caused to turn round with a speed, as has been determined by experiment, of about one-third the velocity of the wind. This portion of the contrivance was the invention of Dr. Robinson, of Ireland. It is used in the foreign observatories, and is known as Robinson's cups.

To the lower end of the shaft thus made to revolve by the cups is attached an endless screw connecting with a train of wheels, which move a cam. The wheels are so arranged that one turn of the cam answers to 15 miles in the movement of the wind. A pencil which rests on the edge of the cam, and bears lightly against a surface, is carried from the bottom to the top of the paper by each revolution of the cam. It should be understood that the paper is attached to a board drawn aside by a clock at the rate of half an inch an hour. The number of times that the pencil moves from the bottom to the top of the paper, multiplied by 15, gives the number of miles that the wind has moved in an hour or day.

DESCRIPTION OF INSTRUMENT.

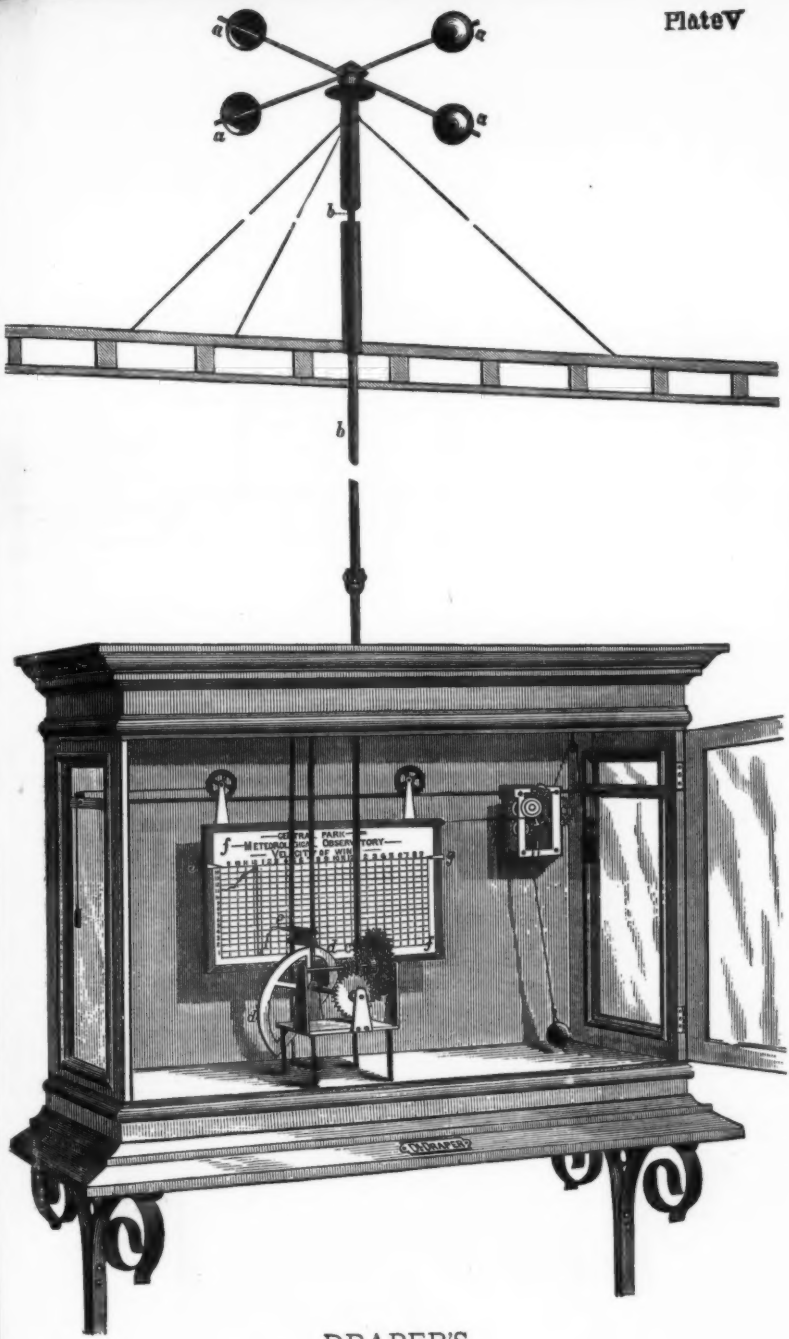
The four hemispherical cups, *a a a a*, turned round by the wind, impart their motion to a vertical shaft, *b b*, at the bottom of which is the endless screw, *c*, its lower end resting in a small agate cup filled with oil, connected with the train

Plate IV.



DRAPER'S

DIRECTION OF WIND.



DRAPER'S

VELOCITY OF WIND.

DRAPER'S

FORCE OF WIND.

of wheelwork turning the cam, *d d*. At *e*, is the pencil resting on the edge of the cam; *f f*, is a sheet of ruled paper attached to the board, *g g*, by means of small brass clamps, which is drawn aside at the above mentioned rate by the clock, *h*.

Instrument for Recording the Force of the Wind.

This instrument consists essentially of a cylindrical metal drum suspended by a chain from an unyielding frame or support, and exposed to the action of the wind, the lower end of the drum being connected by another chain and guide rod with a spiral steel spring, on the top of which a pencil is placed bearing lightly on a sheet of paper fastened to a board, which is drawn aside by a clock at the rate of half an inch an hour.

When the drum is pressed upon by the wind it is pushed in the direction towards which the wind is blowing, and pulling upon the spring causes the pencil to make an upward trace upon the paper. The force necessary to draw the pencil upward to a given point is determined by direct experiment, and expressed in pounds weight upon a square foot. The direction from which the wind blows makes no difference, as it always has the same surface to press upon.

DESCRIPTION OF INSTRUMENT.

The metal drum, *a a*, is made of tin plate; it is one foot in height and one foot in diameter, suspended by a chain, *b*, to a strong support, *c c*, on the roof of the Observatory; its lowest end is connected by a chain and guide rod, *d*, with the spiral spring, *e*, at the bottom of the case. On the top of this spring at *f* is a pencil; it bears against the sheet of paper, *g g*, fastened to a board drawn aside by a clock, *h*, at the above mentioned rate. When the wind blows, the tin cylinder is forced into some other position, as is shown in the dotted figure, *á á*, and the pencil is drawn upwards. The more violent the wind the further will the tin cylinder be pushed aside, and the higher the pencil be drawn.

LITERARY NOTES.

Periodicals.

Nature. A weekly illustrated journal of science, edited in London. Macmillan & Co., 112 Fourth ave., New York. Vol. 31.

(97) Editor: Meteorology of Magdeburg. No. 5; p. 106. A review of the annual report of 1883 of the Magdeburg Observatory and a synopsis of the work done at the observatory during the year. A copy of the photograph of the Dakotah tornado is contained on the same page.

(98) Editor: High level meteorology. No. 12; pp. 261–2. The results of meteorological observations carried on at the top of Säntis, Switzerland, height 8094 ft., are compared with those obtained on the top of Ben Nevis, Scotland, height 4406 ft. The highest pressure at both stations is found in summer, and lowest in winter. The wind at both usually reaches its lowest velocity about midday, and its highest about midnight; just the reverse of what occurs at the earth's surface beneath. During the winter of 1883–4 Ben Nevis was under a deep covering of snow, the sky clouded nearly the whole time, and the difference between the mean lowest and highest hourly temperature only half a degree. "Notwithstanding the practical uniformity of temperature of the surface of the top of Ben Nevis during the twenty-four hours of the day, the curve of the diurnal variation of the wind's velocity was as clearly marked in winter as in summer, and the two curves were alike in showing the occurrence of the maximum shortly after midnight and the minimum shortly after noon. We must therefore conclude that the peculiar type of the diurnal curves of wind velocity on these elevated peaks is altogether independent of the temperature of the surface over which the winds blow." The top of Säntis showed on an average very much less humidity than Ben Nevis, the air at the latter being usually nearly saturated; but within high pressure areas, or anti-cyclones, the air at both stations attained a greater degree of dryness than was ever reached at lower levels in that part of Europe.

(99) Lodge, O. J.: Dust. No. 12; pp. 265–9. The writer gave Aitken's experiment showing that if ordinary air, which is always full of little dust particles, be inclosed in a tube and suddenly cooled by allowing it to expand, its vapor will be condensed into a visible cloud; but if all of the dust be extracted from the air, no amount of expansion will produce clouds, but the vapor will condense on the surface of the containing vessel. This experiment no doubt furnishes an explanation of the mode of vapor condensation in the atmosphere, and shows what it might be were the atmosphere deprived of dust. The writer says:—"Picture to yourselves aqueous vapor accumulating, and increasing in quantity in dust-free air, saturated, over saturated, nothing to start the condensation; it goes on accumulating; the atmosphere becomes unbearably damp, soaking into and through everything. At length at some point something causes it to give way, and condensation takes place. Instantly it spreads from this point as from a center, volumes of liquid are produced, and fall, not as a shower, but as a splash, deadly and destructive by the mere weight and impetus of its fall. Instead of this what really happens? The moisture, on becoming saturated, finds myriads of minute dust particles or nuclei, round which it condenses; the more numerous the nuclei, the more minute may be the globules of mist

formed; it never becomes supersaturated at all. The instant it is saturated it begins to condense, and we have the mist or visible cloud, and in this form it may last for any length of time. Under certain influences, however, not yet fully understood, but which I wish in part to illustrate to-day, these minute drops may congregate into larger ones. Too large to remain slowly falling through the air, they begin to fall more quickly as their size increases, and we get the fine shower; or, if the aggregation goes on further, and the drops do not evaporate much as they fall, we have the heavy down-pour, the thunder storm, or the tropical deluge —all varieties of rainfall caused by the different size of the aggregated water globules."

(100) EDITOR: Relative frequency of storms in the northern hemisphere. No. 13; pp. 293–4. A review of Finley's charts of relative storm frequency.

(101) MCLEOD, HERBERT: A sunshine recorder. No. 24; pp. 319–20. Description with illustration of a new instrument invented by the author. "It consists of a glass sphere silvered inside and placed before the lens of a camera, the axis of the instrument being placed parallel with the polar axis of the earth. The light from the sun is reflected from the globe, and some of it passing through the lens forms an image on a piece of prepared paper within the camera. In consequence of the rotation of the earth, the image describes an arc of a circle on the paper, and when the sun is obscured the arc is necessarily discontinuous."

(102) BUYSMAN, DR. M. Influence of direct sunlight on vegetation. No. 14; pp. 324–6. The influence of the sunlight and heat at various parts of the world on the many kinds of fruit and grain used by man is considered. He shows that the mean amount of light and heat does not determine the adaptability of a place for certain kinds of vegetation, but the amount received by the plants during the critical period of their existence. The range of temperature at a place is also shown to have a great influence on the kind of plant life it will sustain. He shows that the maximum temperatures produced by the sun's rays in summer in the arctic regions is nearly the same as the maximum temperature produced by the sun's rays at the equator, and thus accounts for the rapid and luxuriant growth of vegetation in some portions of the arctic region. He closes by mentioning how much a new system of biometeorological observations is wanted to ascertain the real quantity of warmth and sunlight necessary for the growth of plants, many of which are of the utmost importance in the life of man.

H. H. C.

Das Wetter. Meteorologische Monatschrift für Gebildete aller Stände. Edited by Dr. R. Assmann; Feb., 1885; vol. II; No. 2.

(104) DR. A. V. DANCKELMAN: Die klimatische Verhältnisse der Westküste von Afrika. II; pp. 21–25. This article continues the discussion of thunderstorms began in the last number of *Das Wetter*. The lightning is remarkably brilliant and common, but the thunder is comparatively rare and low. Lightning strokes are rare. The author suggests that this immunity is in part only apparent, as the population is sparse and the inhabitants are not good reporters. He thinks, however, that it is also in part real, and is due to the elevation of the clouds and to the excessive rains which, by wetting objects generally, make them better conductors. The thunderstorms are most common from 6 to 9 P. M. A fall of temperature of 14° to 18° F. accompanies them. Their winds are at times violent enough to take off light roofs or overthrow board-houses. They do much injury to plants, especially to maize and to tobacco. They are however accompanied by heavy rainfall; 3 or 4 inches in an hour or two is a not infrequent fall. Severe and long-continued storms are unknown; as also is hail on the coast. The finest season is at the beginning of winter.

(104) DR. ASSMANN: Vom Brocken; pp 25–33. The author makes an occasiona

residence with the regular meteorological observer on the Brocken to carry out special investigation. In one visit to the top of the mountain, in late autumn, he studied the elements of clouds, and found them always drops with no sign, under his highest magnifying power, of a solid, or dust nucleus as is required by Aitken's theory. The largest droplets were below, the smallest in the center of the cloud. During a winter visit he made an especial study of the hoarfrost. On the mountain top it is formed in astonishing quantities, so great that the telegraph wires can not be be kept up, and the telegraph poles become pillars whose diameters are to be measured in meters. In January, in one case, he found the diameter to be nine feet. The form, position, and direction of the crystals in hoarfrost depend on the direction of the wind, and change with the change of the latter. A very interesting fact is that the droplets of clouds were found to remain still liquid, when free in the air, to temperatures as low as 9° to 14° F.; when, however, these undercooled droplets came in contact with solids they froze at once without apparent crystallization. The article is one of unusual interest and suggestiveness.

(105) Uebersicht der Witterung des December, 1884, in Central-Europa; pp. 32–37.

(106) Feld- und Saatenstandbericht, aus der Mark—January. 1885; p. 37. The season is more favorable than usual for agricultural operations.

(107, FRIEDERICH TREITSCHKE: Witterung auf dem Inselsberge; 1884, pp. 38–40. This is a mountain about 3,000 feet high, 26 miles southeast of Erfurt. Simultaneous observations are carried on at Erfurt and on the top of Inselberge. The Brocken is 65 miles distant and the transparency of the air was tested by its visibility. This was recorded 55 times during the year. Occasionally the Brocken was visible from Inselberge when intervening objects could not be seen; this was when both were standing above the clouds. H.

Ciel et Terre. Revue populaire d'Astronomie, de Météorologie et de Physique du Globe, paraissant le 1er et le 15 de chaque mois. No. 24; Feb. 15, 1885.

(108) P. STROOBANT: L'aggrandisement des astres à l'horizon. The author thinks that two distinct causes contribute to the apparent enlargement of the sun and moon at the horizon: 1. Every object placed in the zenith appears only 0.8 of the size which it appears to have on the horizon. This was experimentally tested by taking two pairs of lights, at the same distance from the observer, in a dark room, one pair being above, the other at the side. The lights below were moved until they appeared to be at the same distance as those above. On measurement they were then found to be actually at only 0.79 to 0.81 of that distance. The same test was applied to the stars by seeking a pair in the zenith which appeared to be at the same distance apart as a selected pair in the horizon. The ratio was here found to be 0.797. No explanation of the phenomenon is hazarded. 2. The diminution of brightness at the horizon makes the body appear farther off and consequently larger. This is also seen when the sun or moon are observed through fog or thin cloud. They always then appear larger. H.

BOOKS, REPORTS, ETC.

(109) **H. B. Baker, M. D.** Typhoid Fever and Low water in Wells. Reprinted from the Annual Report of the Michigan State Board of Health for 1884, Lansing 1885; pp. 89–114.—Dr. Baker calls attention to the coincidence of low water in wells and the unusual prevalence of typhoid fever in Michigan, in the latter half of 1881 and the first quarter of 1882. This coincidence is sufficiently marked to deserve a careful study, and to that is the paper devoted. When the depth of the water surface in wells is compared with the amount of sickness and the number of deaths from typhoid fever, for each month for the five years,

1878–1882, the coincidence is striking. At the same time the typhoid curves lie slightly behind the curve for depth to water surface, and this lagging is most marked when we compare the curves by single years. Having made out an apparently clear case, the author goes on to discuss the specific cause of typhoid fever, as indicated by the results he has reached. It seems that when the waters are low, the solution of uncleanness, which causes the disease must be concentrated. To the layman in medical matters this part of the paper is a powerful appeal for that cleanliness which is next to godliness. H.

(110) **Hon. Ralph Abercromby, F. R. Met. Soc.** Principles of Forecasting by Means of Weather Charts. Issued by order of the Met. Council. No. 60; London, 1885; 124 pp.; 8vo; 65 figures. This publication of the English Meteorological Office is intended to give the public information necessary to enable it to use weather maps to the best advantage. The attention of the reader is directed at once to the appearance of the cyclone on the weather map, and he is led to notice the characteristics of the former as they appear on the latter and the weather consequent on such characteristics. The publication is eminently practical. The most original part is found in the weather types, which the author has studied out, and the fluctuations in these types. We are led to think that a somewhat different classification would be found necessary in this country. The reader is not allowed to lose sight of the value of upper-cloud observations, and one of the appendices gives provisional instructions for observing them. Appendix III gives opinions respecting the value of storm signals, as given by the local authorities when these signals are displayed. The unanimity of favorable opinion is greater than might have been expected. H.

(111) **Jahrbücher der k. k. Central-Anstalt für Meteorologie und Erdmagnetismus.** Officielle Publication. Jahrgang 1882; Neue Folge; XIX. Band. Two parts; Vienna, 1884; 4to; 326 pp. This is the official volume of the Austrian Meteorological Service. The first part contains the tri-daily observations at 19 stations, of which all are in Austria except Alexandria, Beirut and Sulina; also hourly readings from the automatic registers of pressure, temperature, velocity and direction of the wind, and sunshine at the central station in Vienna; also abstracts of hourly temperature readings for Klagenfurt and Obergipfel and pressure-readings for the former; also magnetic observations, including absolute determinations, tri-daily variations, and hourly readings from Adie's magnetograph. In the second part are the abstracts of the observations in stations of the first and second order, 284 in number, and in an appendix are given the results of observations at six stations on Cyprus. Comment on this publication is hardly called for. It must serve as model for similar publications elsewhere. It is prepared under Dr. J. Hann, the director of the service. H.

(112) **Berliner Zweigverein der deutschen meteorologischen Gesellschaft.** Zweites Vereinsjahr, 1885, Berlin; 12 pp.; 8vo. This little pamphlet is the official proceedings issued by the secretary, Dr. G. Hellmann. The Berlin branch of the German Met. Soc. has now 88 members on its list, and among them it is so fortunate as to have several eminent names. There have been seven regular meetings during the year, the papers and lectures before which covered a large field. Judging by this pamphlet the Berlin branch has been eminently prosperous, and must prove an excellent promoter of the science in that city. H.

(113) **W. H. Lamar, Jr., and Frank W. Ellis.** Physical Observations during the Lady Franklin Bay Expedition of 1883. Signal Service Notes, No. XIV—Supplement to Signal Service Notes, No. X. Washington, 1884; 8vo; 62 pp; 1 map, and many lithograph copies of photographs. We have here the notes of physical observations made by Ser-

geants Lamar and Ellis, on board the vessels of the relief expedition to Lady Franklin Bay in 1883. The notes include regular meteorological observations and extracts from journals from June 13 to August 31, and magnetic observations at Saint John's and Godhavn. The map gives the courses of the Proteus and Yantic and of the boats on retreat, with approximate positions at the times of observations. Of great interest are the copies of photographs, though perhaps a prudish taste would have omitted one of them. They convey, in a more graphic manner than notes possibly could, a realization of the desolation of the arctic regions, and also give one clearer ideas of the appearance and dress of the natives. H.

(114) **Bulletin of the New England Meteorological Society.** No. 3; January, 1885; 8vo; 8 pp.; 1 map. The society has now 71 stations, of which all are in New England except one, which is in New Brunswick. The map gives, in neat graphical devices, the range of temperature and amount of precipitation for the month. A sketch of the general weather conditions is given. We note thunder and lightning as reported on the 28th at Taunton and Cotril. The society desires to increase its membership and number of observers as much as possible. From the former an annual fee of $3.00 is required, and we take it that members are not required to reside in New England. The secretary is Prof. W. M. Davis, of Cambridge, to whom all letters concerning the society and membership should be addressed. The director is Prof. Winslow Upton, of Providence, and to him all correspondence concerning observations should be addressed. H.

(115) **Report of the Ohio Meteorological Bureau for January, 1885.** Professor T. C. Mendenhall, Director; E. A. Mark, Secretary; Columbus, 1885; 50 pages. A thunderstorm was reported from several stations on the 11th. The verifications for the railway signals was very good. Mr. John W. Gray, the observer at Ironton, reported a severe wind storm as occurring on the night of the 23d between 9 and 10 o'clock. He said: "The hardest wind storm that has been known for years in this region, occurred Friday night, the 23d inst, between 9 and 10 o'clock. It seemed to come from the S. W. It took the roofs off of several buildings, broke windows in, and blew down telephone poles and chimneys. Some say it had the form of a tornado. The furnace here was letting out cinder, which reflected a bright light on the sky. By this light the cloud was seen. Those who saw it say it was black as ink, and funnel-shaped. I did not see the cloud myself, and can only give it to you as described to me. The wind sounded like a freight train in motion." H.

(116) **Dr. Charles G. Boerner,** publishes monthly, on a separate sheet, a neat summary of observations at Vevay, Switzerland Co., Indiana. It includes the usual meteorological observations with maxima and minima.

(117) **Monthly Weather Review, January, 1885, Meteorological Service, Dominion of Canada.** Charles Carpmael, superintendent, Toronto. 10 pp. The lowest temperature recorded was at Pheasant Forks, Assinaboia, where the thermometer on Jan. 1 went down to —50°. This was the reading of the ordinary thermometer at the hour of regular observation. A minimum thermometer would have, perhaps, given some degrees lower. The lowest reading of a minimum thermometer was at Oak Lake, Manitoba, where, on Jan. 1, the temperature was —49°.4. The greatest monthly snowfall recorded was 77 inches at Durham, Ontario, and we do not find more than 15 inches of snowfall in any 24 hours, this amount having fallen at several stations, generally on the 15th of the month. A thunderstorm occurred on the 9th at Halifax. There is the usual magnetic review for the Toronto observatory. In the diagrams

of winds, the prevalence of westerly winds is remarkable. H.

(118) **Report of the Tennessee Weather Service for January, 1885.** Published by the Bureau of Agriculture, A. J. McWhirter, director, Nashville, 14 pp. and a map of isotherms and winds. Thunderstorms were reported from many localities on several dates, but most generally on the 11th. The director hopes for an appropriation from the legislature to enable him to put into operation a system of railway weather Signals. H.

(119) **Michigan Crop Report,** January 1, 1885; No. 39; also for Feb. 1st, No. 40. Prepared and published by the Secretary of State, Lansing; each 8 pp. Contains meteorological observations from 29 stations. This little monthly is required by statute and is edited with care. It usually contains matter of interest to readers outside of the state and would probably be regularly sent to any one desiring it. Applications should be made to the secretary of state at Lansing. H.

(120) **W. G. Blish.** The Gyroscope and Top, 6 pp.; 12mo. Published probably at Niles, Mich. As is well known to physicists, the problems presented by some of the simplest toys are among the most difficult to solve. The kite, the top, the soap-bubble, and, not properly a toy, the gyroscope may be mentioned as illustrations. Some of the problems connected with them are yet incompletely solved. Mr. Blish, who found the usual explanations for two of these objects unsatisfactory, has worked out a brief theory of them for himself, which he presents in this brief pamphlet. The publication has at least the recommendations of care, thoughtfulness, and temperate treatment. H.

(121) **Alabama Weather Service, January, 1885.** Issued through the Department of Agriculture. P. H. Mell, Jr., director, Auburn; 18 pp., and a map. Thunder-storms were general throughout the State on the 11th and 27th. The account of the tornadoes of the 11th we hope to reproduce elsewhere. H.

(122) **Nebraska Weather Service Bulletin, February, 1885.** Goodwin D. Swezey, director Boswell Observatory, Crete, Nebraska. Reports from 27 stations. The past February was the coldest since the organization of the service (8 years), and also, with one exception, the February of greatest snowfall. A single thunder-storm was reported from the Republican Valley. H.

(123) **Denison's Annual and Seasonal Climatic Map of the United States.** Rand, McNally & Co., Chicago, 1884.

The material for these maps comes wholly from the annual reports and professional papers of the Signal Service. The set consists of one annual and four seasonal maps, on which the chief climatic factors are pictured with much distinctness. Isotherms and rainfall are shown by lines (the annual rainfall has an unexplained difference from the lines on Lieut. Dunwoody's map), but the cloudiness and a composite measure of humidity are indicated by colors. The results are clearly shown, but unless certain essential steps in the method of preparation are omitted in the brief explanation given on the maps, we should have to take exception to the correctness of some of them. The map of annual percentage of cloudiness exhibits certain peculiar contrasts with that of Europe by Renou, for which our mountain ranges and the difference of latitude must be held chiefly accountable. In Europe the cloudiness is very closely in inverse proportion to the distance from the western (Atlantic) coast; in our country, the western half is relatively free from clouds, while the maximum is about the Lakes, where storm-centres are most frequent. Indiscriminate records of cloudiness are, however, not well adapted for illustration on a single map; the bright, clear sky mottled with scattered cumuli on the dry, after side of a storm ought never to be averaged with the cirrus sheet with its increasing

moisture on the front; but this difficulty is unavoidable so long as the records are thus published by the Signal Service. As the maps are prepared with especial reference to climatic conditions that affect health, it would be well to add others to them, showing Supan's lines of equal annual variation, and Hann's measure of the irregularity of weather as gauged by the average difference between the means of successive days.

W. M. D.

(124) *Pubblicazioni del reale osservatorio di Brera in Milano, No. 26.* **Sulle variazioni diurne del magnetismo terrestre** *risultati di osservazioni fatte a* **Milano** *negli* **anni 1872 e 1877**; *calcolati e dedotti da Michele Rajna, terzo astronomo dell' osservatorio di Milano. Milano, Ulrico Hoepli, editore-librajo, 1884.*

fol. 60 pp. 8 lithograph plates.

The paper, whose title is above written, is a very clear and satisfactory account of the *Diurnal variations of the magnetic declination*, of the *dip* and of the *intensity* at Milan in the years 1872 and 1877, and thus has the merit of a strict conformity to the promise of its title page. It consists of *three* parts which are:

1st. Nine pages of introductory and historical matter by Prof. G. V. Schiaparelli.

2d. Sixteen pages of letter-press, by Dr. Rajna, descriptive of the observations used, the mode of calculation and deduction of results; and

3d. Thirty pages of tables embodying the results; these results being still farther shown graphically on 8 lithographic plates, very clearly and neatly executed.

It should also be noted that the memoir contains one very valuable table covering ground outside the limits of the memoir proper. This is a table giving *mean monthly* and *mean annual* values of the amplitude of the diurnal oscillation of the declination magnet for 48 years, 1836–1883, both inclusive; the only break in this long series is one of 6 months in 1869. In the same table are printed, for comparison, Wolf's sun-spot numbers, from which the general relation between sun-spots and amplitude of magnetic declination variations is immediately and conspicuously obvious. Four cycles of sun-spot maxima are embraced within the limits of the table, and in each case the maximum and minimum spottedness of the sun corresponds respectively to a maximum and minimum of amplitude of oscillation of the declination magnet.

This very long and complete table sharpens our desire to know some details of the observations carried on for so long a period, and we need offer no apology, therefore, for summarizing the interesting facts in Prof. Schiaparelli's introduction.

Magnetic observations were begun at Milan in 1836, by Charles Kreil, an assistant in the observatory. It might almost go without saying that the great Gauss, the head of the Magnetic Union, was the inspirer and director of these earliest observations, which, with various modifications, have been kept up down to the present time. These observations consisted of both absolute and relative measures of the magnetic elements. The results of the observations of 1836–1838, for diurnal variations, were published as supplements to the Milan Nautical Almanac (Effemeredi astronomiche di Milano) by Kreil and Della Vedova, and until the present publication were the best published data available on the subject.

Magnetographs do not appear to be in use at Milan, the observations here discussed being eye observations, and the apparatus used being the old forms devised by Gauss and Weber fifty years ago.

In 1836–1838 observations of declination were made some 10 or 12 times daily. In 1839 the bifilar was introduced and observations upon the two magnets then made only four times daily. Variations of dip were observed with an instrument devised by Kreil, but the

results being unsatisfactory, these observations were given up in 1841.

From 1845 to 1855, the magnetic work at the observatory was confined to two daily observations of the declination magnet, the observing hours being 8 A. M. and 2 P. M. From 1855 to 1870 corresponding observations of the bifilar were added.

In 1871 a general *resumé* of results obtained from the beginning of observations in 1836 was published. From this discussion was revealed the importance of more observations in all parts of the 24 hours in order to fully bring out all the peculiarities of the daily variation.

It was thereupon decided to undertake a series of observations of the variations of the magnetic elements, covering a period of two years, one a year of *maximum* sun-spots and the other a year of *minimum* sun-spots, the observations to be made at short and equidistant intervals throughout the 24 hours.

The years selected for this purpose were 1872 and 1877 respectively. There was delay in beginning and the series of observations, embracing readings of the declinometer, bifilar and balance magnetometer, actually began April 1, 1872 and ended with March, 1873. During 1872 observations were made at 2, 5, 8, and 11 A. M., and at 2, 5, 8, and 11 P. M. During the three months of 1873 observations were made at 8 and 10 A. M. noon, 2, 4, 6, 8, 10 and 12 P. M., by four observers, among them being Prof. Schiparelli, the present director of the observatory. Throughout 1877 similar observations by 4 observers, as before, were made at 3, 6, 8, 9, 10 and 11 A. M., noon, 1, 2, 3, 6 and 9 P. M. and midnight.

The discussion of these observations and deduction of results constitute the present memoir.

As already indicated the instruments used were the old ones constructed by Meyerstein, of Göttingen, 1835, in accordance with the views of Gauss. The magnets are two feet long, weigh about 4 lbs. each, and have very long supension skeins. The scale divisions—which can be read to tenths—correspond to about 0′.5 so that the readings are to about 3″. The time of one oscillation of the declination magnet is about 40 seconds and of the bifilar about 20 seconds. One scale division of the bifilar corresponds to a variation of the horizontal force of its $\frac{1}{1\,1\,5\,0}$th part. In the balance magnetometer the magnet is supported—not on a knife edge—but upon two steel points resting on an agate plane. The results, however, show the same irregular and peculiar breaks that occur with the knife edge support.

The temperature coefficient was determined from a comparison of the observations in spring and autumn and was found for the bifilar to be 2.23 scale divisions for 1° Celsius. The arrangements for securing uniformity of temperature were excellent, the temperature of the magnets being almost absolutely constant. The very small daily range of temperature of the air at Milan is favorable to securing this result. In 1877 the average daily range of atmospheric temperature for the whole year was 11°8 F., (6° C.), for July, 15°.3 F., (8°.5 C.), for August 14°.6 F., (8°.1 C.), and for December, 6°.3 F., (3°.5 C.). But the mean daily range of temperature of the bifilar magnet during August was only 0°.04 F. (0°.022 C.)! or $\frac{1}{1\,1\,7}$th part of the range of the atmospheric temperature.

The presence of spiders appears to have given annoyance, and to prevent the magnets from being "anchored" they were vibrated from time to time thus insuring their freedom.

In the memoir proper Dr. Rajna sets forth in a very lucid and satisfactory manner the course pursued in reducing the observations and the method of calculating the *hourly* results from *tri-hourly* observations. The method by which disturbances were eliminated does not, however, appear to be conspicuously set forth.

No *absolute* results are given except for the dip; for this element we find the following values:—

1836.8	63°44′.6
1867.6	62 25 .5
1872.5	62 12 .6
1877.5	62 00 .1

showing an annual diminution of about 2′.5.

In general the north (seeking) end of the declination magnet attains its eastern elongation between 7 and 8 A. M., and its western elongation between 1 and 2 P. M. the amplitude of the swing being about 10′ in years of maximum sun-spots and about 6′ in years of minimum sun-spots. There is also a secondary maximum and minimum in the diurnal motion of the magnet which comes out strongly in the winter months, but which nearly disappears in summer. During these winter months the eastern elongation—instead of occurring between 7 and 8 A. M.—occurs between 10 and 12 P. M., *i. e.* the secondary eastern elongation becomes the principal one.

In the case of the horizontal intensity the variations from month to month show so much irregularity that they cannot be generally characterized in brief, except it may be noted that a persistent tendency is shown throughout the year to the manifestation of a minimum of horizontal force between 9 and 10 A. M. Also the amplitude of variation of the horizontal force is greatest in years of maximum and least in years of minimum sun-spots.

In the case of the vertical force there is a marked tendency throughout the year towards a maximum of force about 6 P. M., and a minimum about noon. As in the other cases the amplitude is greatest in years of maximum sun-spots and *vice versa*.

The variations of total force closely resemble those of the vertical force.

The dip shows a very marked tendency in all months except January and February to be a maximum at about 8 or 9 A. M., being then about 1′.5 in excess of its mean daily value, the time and amount of the minimum is much less regular or well defined. M. B.

CORRESPONDENCE.

EASTWARD MOVEMENT OF THE AREA OF COLD DURING THE PRESENT WINTER.

MR. EDITOR:—A study of the Signal Service morning weather map shows that there has been apparently a slow, but decided, eastward movement of the area of greatest cold during the present winter. Between the 11th and 31st of December, I have eight morning weather maps, clipped from the *New York Graphic*. The area of minimum temperature on these maps occurred within or north of Montana on three mornings, within or north of Montana and Dakota on three mornings, within Montana and Wyoming on one, and north of Dakota and Minnesota an one. I have twenty-eight maps between the 1st and 31st of January. These show the area of greatest cold within or north of Dakota and Minnesota on eighteen mornings, north of Minnesota and Wisconsin on four, north of Montana and Dakota on one and north of the Lake Region on one, Between the 1st and 28th of February, I have twenty-two maps. These show the area of greatest cold within or north of the Lake Region on ten mornings, north of Dakota and Minnesota nine mornings, north of Minnesota and Wisconsin one, in Canada one, and in New England one. Between the 1st and 18th of March, I have fifteen maps. On these the position of the lowest temperature was in Canada on ten mornings, in the Lake Region on three, and north of Dakota and Minnesota on one. It will be thus seen that the area

of greatest cold was found north of Montana three times out of eight during December, and on not a single weather map since then have I found it so far west. The December *Monthly Weather Review* of the Signal Office (the last one received) shows the average temperature for December was 20° below the normal in Montana. The lowest temperature was found within or north of Dakota and Minnesota three times as often in January as at all other places put together. Only once was it found east of the 90th meridian, and this was on the 31st. In February the area of minimum temperature was found within or north of the Lake Region oftener than anywhere else (perhaps it could have been placed oftener in this region than it was if the stations had extended as far north as they do on each side of it), and only twice was it found east of the lakes. Not a single time up to Feb. 26, had the lowest temperature on the map been found in Canada; but up to the present time in March, it has been found three times as often in Canada as anywhere else; and not but once has it been found west of the Mississippi River. So marked has been the tendency for the area of greatest cold to occur in Canada during March, that on the mornings of March 3, 6, 9 and 14, the lowest temperatures were found in the front of well developed cyclonic systems central in the Lake Region, while to their rear the isobars stretched away to the northwest. This is just the reverse of what has been established as the law in such cases.

On the morning of the 9th, the cyclonic center was over Lake Superior (lowest isobar 29.60), and in Canada the temperature was twenty below zero, while in Dakota it was thirty above, and in Montana forty above—a difference of 60° F., in the same latitude, between the front and rear of the cyclone. On the 14th there was again a difference of 60°, and on the 13th of 70°.

In order to render the movement visible by means of curves, I smoothed the temperatures reported once a day by the Signal Service, for six widely separated stations, from Jan. 1st to the present time; and I found that the temperature curves, besides showing an eastward movement of the area of cold, showed that the temperature had gone through oscillations of short duration, similar to those I have shown in the twenty-five months' cycle. I will give these a closer study as soon as I have time.

To give a further illustration of the movement of the area of cold, I select from my newspaper files the most westerly station—Helena, Montana—and the most easterly—Albany, N. Y.—from which signal service temperatures at 11 P. M. are given; and tabulate the temperatures reported from these stations during a week in January, and during the week just ended.

Jan.	Helena.	Albany.	March.	Helena.	Albany.
13....	4°	19°	12.....	46°	— 1°
14.....	— 6	22	13.....	51	20
15.....	—10	29	14.....	Reports missing.	
16.....	4	28	15.....	51	26
17...	1	12	16.....	31	15
18.....	— 1	12	17..... ...	33	5
19.	—10	12	18..... ...	41	11

The movement of the area of greatest cold does not mean that the north alone was affected, but that the whole country has successively felt its influence. My curve for El Paso, Tex., shows that the lowest mean temperature occurred there in January; while the monthly report just received from Mr. Mell, of Alabama, shows that the average temperature of that state for February was very low for that latitude, and slightly lower than that of any of the winter months; as it was decidedly so in the Lake Region.

It is apparent from the illustrations

and the table I have given that an area of warmth has developed in the Northwest. May we not hope that this like the area of cold, will sweep over the country, and give us a pleasant spring after our long winter? If I should hazard a guess as to the coming weather in the Lake Region, I should say—a period of considerable warmth during the first part of April (though the thermometer is hanging at the zero line at present), a cooler period about the 15th to the 20th, and warm again during the first of May. This is merely a conjecture, however, founded on meagre data.

HENRY HELM CLAYTON.

ANN ARBOR, MICH., March, 19, '85.

THUNDERSTORM OR TORNADO? ELECTRICITY AND TORNADOES. ALSO, A NOTE ON THE TORNADO OF APRIL 23, 1883.

TO THE EDITOR:—The morning of Dec. 22d, 1884, opened with thunder and rain, both of which continued throughout the day, at intervals, till awhile after sunset. At first the clouds passed from south to north, but about 2:30 P. M. a change took place. Distant thundering was heard to west and northwest, and it soon became apparent that the cloud, from which it issued, was advancing towards me, and half an hour afterwards, when it was some twelve or fifteen miles distant it began to put on a very ugly look. Heavy rain was falling from it for many miles between Columbia and Camden, and near the centre of the cloud there began to ascend, from a point several hundred feet above the surface of the earth, a mist or fog, widening out as it connected with the cloud, the edges, however, very ragged and ill-defined. This cone of mist did not increase in darkness or density and, before the cloud had come overhead, was lost in the rain and spray with which the air was filled. About ten minutes before rain began to fall, the wind suddenly backed round from south or southwest to the east, and after a minute or two as suddenly bounded around to northwest and west, and springing immediately into a fresh breeze it gradually increased, until for a few minutes while rain was falling, it attained the velocity of twenty to twenty-five miles an hour. Rain only lasted five minutes accompanied by a few hailstones the size of a cherry the first minute or two. Five miles beyond my residence, to the eastward, the storm developed into a limited tornado of about a mile and a half in extent, singularly enough striking just where the tornado of April 23d, 1883. left off. Later in the day a tornado of great violence prevailed about fifteen miles southward in Clarendon County clearing a track fifteen miles long. I noticed that the lightning flashes in this cloud played about and expended themselves within the cloud or clouds, at no time was there any discharge descending to the earth, as is always the case, more or less frequently during an ordinary thunderstorm. This fact was also noted by me as a peculiarity with regard to the lightning on the occasion of the tornado of April 23d, 1883. It was further noted on the 22d December that for sometime before and after the cloud passed overhead there was issuing from it a very distinct roaring or rushing sound, like that produced by a heavy rain or a high wind a little distance off. When the electric current is passing along a telegraph wire, does it not produce a humming sound, which can be distinctly heard by applying the ear to one of the supporting poles? I think so, and I can attribute the rushing sound, above mentioned, only to a current or currents of electricity in active circulation; that is, the electricity with which the cloud was charged was in a dynamic state rather than static.

Furthermore the sound of the thunder differed very decidedly from the peals issuing from an ordinary thunder cloud, when delivering its discharges from the cloud to the earth. It had not that

sharp, explosive, crashing sound, like the detonation of a rifle cannon, which characterizes the latter, but to my ear was more like the sound produced by a heavy ball rolling over a hollow surface like a floor or bridge, as though the cloudy vault had been provided with a vast floor over which each flash of lightning would hurl a huge cannon ball, the sound of which, receding with the swiftly rolling ball, would at length lose itself in the distance, fading gradually away into the continuous rushing sound.

These facts seem to me to indicate conclusively that the electric condition of the tornado cloud differs very materially from that of the ordinary thunder cloud, or that the electric state of the one relatively to the electric state of the earth differs very materially from that of the other in its relationship to the earth.

Then too, does not the supposition, that the potent and mysterious force of electricity is brought to bear as an active agent in the operations of the tornado, offer a more satisfactory solution of many of its strange and peculiar features than it is possible to derive from the ordinary forces developed in other storms, to whatever extent they may be intensified or magnified?

Among these peculiar features may be mentioned the rapid variations in form and color of the cloud and its occasionally somewhat luminous appearance; the eccentric action of the forces in many instances as though endowed with the power of discrimination or selection, like the thunderbolt, demolishing one object and leaving unscattered another in immediate juxtaposition, and finally the extraordinary regularity and order in which the forces strike from different directions.

I am glad you did not use the hastily executed map I sent you, for a farther and more thorough examination of the track has shown me that I underestimated very much the extent of the minor axis of the Q. It is nearly, if not quite, as great as the major axis, being not less than seven hundred yards.

Yours truly,

W. W. ANDERSON, M. D.

STATEBURY, S. C., March, 1885.

[The usual explanation of the singing of the telegraph and telephone wires is, that it is æolian; living in a well wired and windy establishment with these sounds frequently so loud as to disturb sleep, we long ago learned that they were independent of the use of the wires but were dependent on the velocity and direction of the winds. The quality and volume of the sounds is modified by the resonance of the individual telegraph-poles; and we have one pole that sings louder than the others, and often sings when the others are silent.

As to the relation of electricity to tornadoes, we can hardly believe that it is causal principally because it is not universally observed in them. Of the 600 tornadoes in Mr. Finley's lists, only 17 were reported as showing electric phenomena in the cloud and in some cases no thunder or lightning were reported in the entire history of the storm. Nor can we conceive of any electric distribution which would give rise to the phenomena of tornadoes. The electric theory of tornadoes was upheld many years ago by eminent authority, as Peltier, and Hare, and has been supported by juries in insurance cases, but we think it is now generally rejected by meteorologists and electricians.]

TORNADOES AND CONTRASTS OF TEMPERATURE.

TO THE EDITOR:—Enclosed are tables of temperature for 25 days on which tornadoes occurred and 25 days on which no tornadoes occurred. The highest and lowest temperatures are given from the daily weather bulletin and the highest on the same longitude as the lowest, as the bulletin is for the same actual time for all stations. The result would seem to

indicate that extremes of temperature is not a sufficient cause for tornadoes.

Yours truly,

J. F. LLEWELLYN.

MEXICO, Mo., Feb. 15, 1885.

[We regret that we have not space for Mr. Llewellyn's tables. They show unmistakably that the contrasts of temperature over North America are quite as notable on days of no tornadoes as on those on which tornadoes occur. But Mr. Llewellyn's tables compare places as distant as Minnedosa and Galveston or Jacksonville, Fla., while, we take it, the supporters of the relation of tornadoes to temperature-contrasts would require the contrasted points to be not far apart. In other words, Mr. Llewellyn's temperature *gradient* (the change in temperature for each geographical degree) is small, while for tornadoes it must be large.]

MAXIMUM AND MINIMUM THERMOMETERS.

TO THE EDITOR:—Will you please inform me why the mercury remains up in the tube of a maximum thermometer, and why the index is only moved downward and not upward in a minimum thermometer? OBSERVER.

[In both cases the maker of the instruments has taken ingenious advantage of very familiar things. In the maximum thermometer he has skilfully broken the column of mercury and admitted a little air into the break. When the mercury expands, it drives the broken end of its column before it, but as the latter does not adhere to the former, when it contracts it leaves the broken column behind. The instrument is placed horizontally to keep the broken part of the column from descending by its own weight. In the minimum with alcohol and a metal index, advantage is taken of the surface tension of the liquid. As this tension is only at the surface, the index is drawn down with it, but left behind when the liquid rises. Consult any good text book on physics, as Ganot or Deschanel.]

WARM WAVES AND COLD WAVES.

TO THE EDITOR:—Would you please tell me where the "cold" and "warm waves," which one sees so often mentioned in the newspapers of late, originate and in which direction and about how rapidly they travel across the United States? O. I. C.

[The "warm waves" are cyclones, the cold waves anti-cyclones. They usually come from the far west, but sometimes originate in, or just east of the Rocky mountains, more rarely in the Mississippi Valley, occasionally in the Lake Region or Eastern States. They usually come to us from the high northwest and travel to the eastward, passing to the Atlantic Ocean generally over the Gulf of St. Lawrence. The rate of travel of the cyclones varies from 10 to 50 miles an hour, usually about that of a railway train, but somewhat greater as they approach the ocean. The anti-cyclones are more erratic in their course and more variable in their velocity, though in general they resemble the cyclones in both respects. For further details see Davis' "Whirlwinds, Cyclones, and Tornadoes" (inexpensive, Lee & Shephard, Boston, 1884) and Prof. Loomis' papers in the *American Journal of Science.*]

DAILY CHANGE IN VELOCITY OF WIND.

TO THE EDITOR:—Will you inform me why the wind nearly always blows with a greater velocity about midday and during the afternoon than it does at night? E. T.

[The velocity of the wind depends on the rapidity of change in the air pressure. When the change of pressure is rapid, the wind is high, and *vice versa*. The air pressure has a daily change; it is highest at about 10 A. M., and lowest at about 4 P. M., and its most rapid change in passing from the forenoon maximum to the afternoon minimum is at about noon. Hence the wind is usually highest at noon. There is a minor evening

maximum at about 10 P. M. and morning minimum at 4 A. M., but these are smaller and do not have so decided an effect on the wind.]

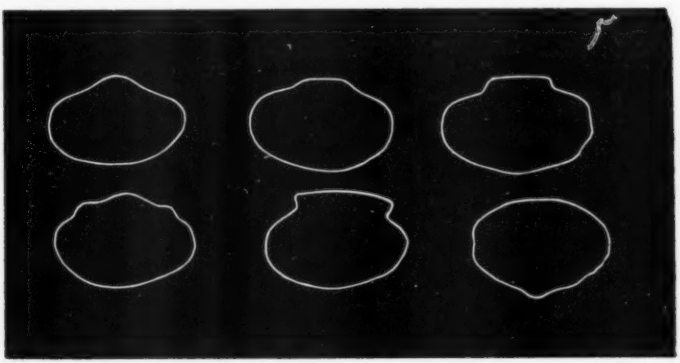
ABNORMAL HORIZONTAL REFRACTION.

To the Editor:—I saw a few days ago, in the American Meteorological Journal, mention of a case of "abnormal refraction" by which the setting sun was given a rather unusual appearance. On the morning of the 19th of the month I noticed a very marked phenomenon of the same kind. The sun rose through the somewhat smoky atmosphere over Washington City, and I first noticed that the apparent shortening of the vertical axis was unusually great; it then began to appear very much distorted and passed rapidly through the different forms below. Respectfully,

E. M. Van Harlingen,

Ft. Myer, Va., Feb. 25, 1885.

[The subject of variations in horizontal refraction has both astronomical and meteorological interest. We would be glad to have other notable cases reported. Any variation in lateral refraction would be especially interesting.]



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